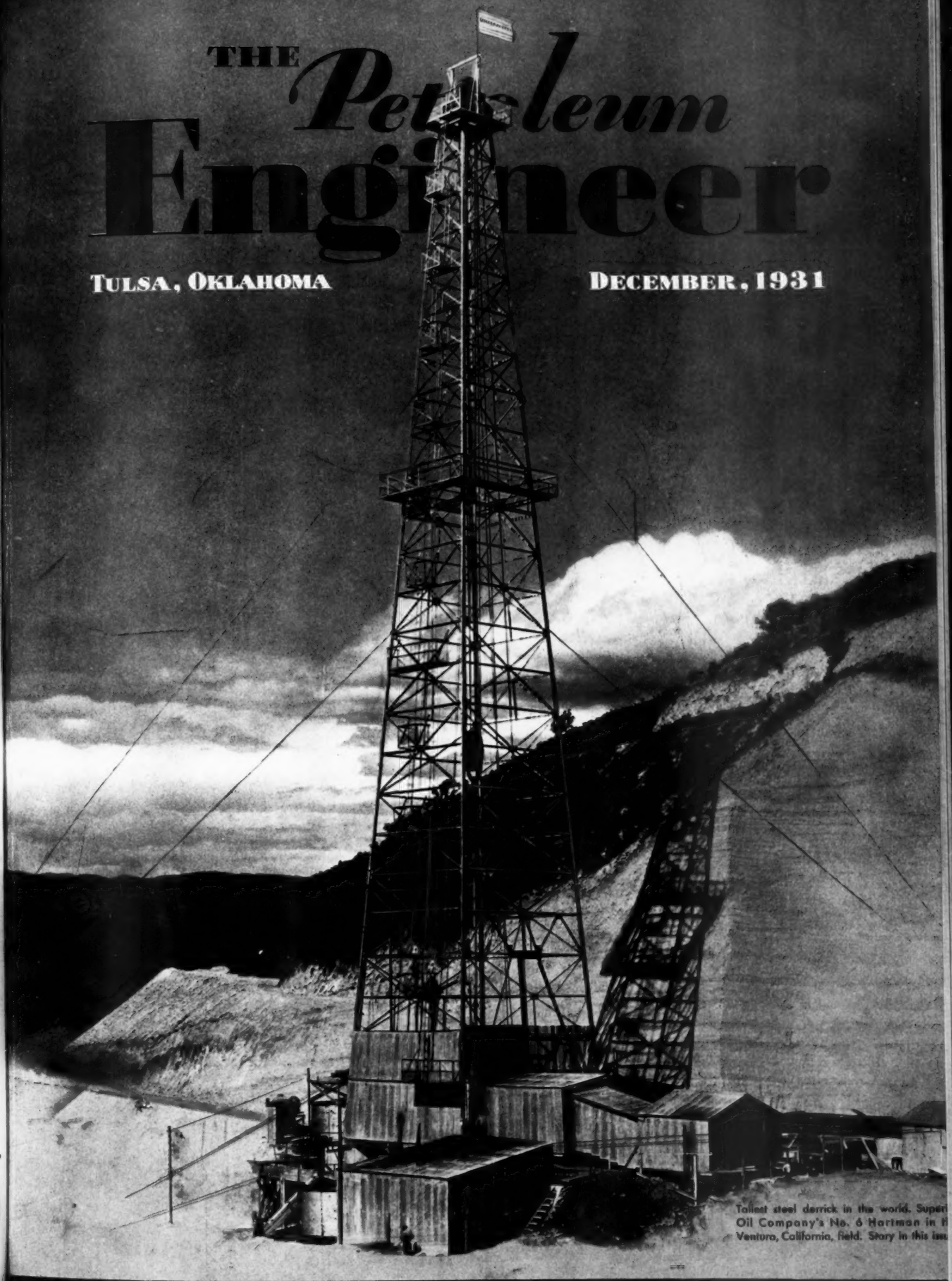
THE Petroleum Engineer

TULSA, OKLAHOMA — DECEMBER, 1931



Tallest steel derrick in the world. Super
Oil Company's No. 6 Hartman in
Ventura, California, field. Story in this iss

THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

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THE Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for those Actively Engaged in the Operating Departments of the Industry

Published 13 times a year; monthly on the 15th with the exception of June, in which two issues appear—the Engineering Review number on the first and the regular June issue on the 15th.

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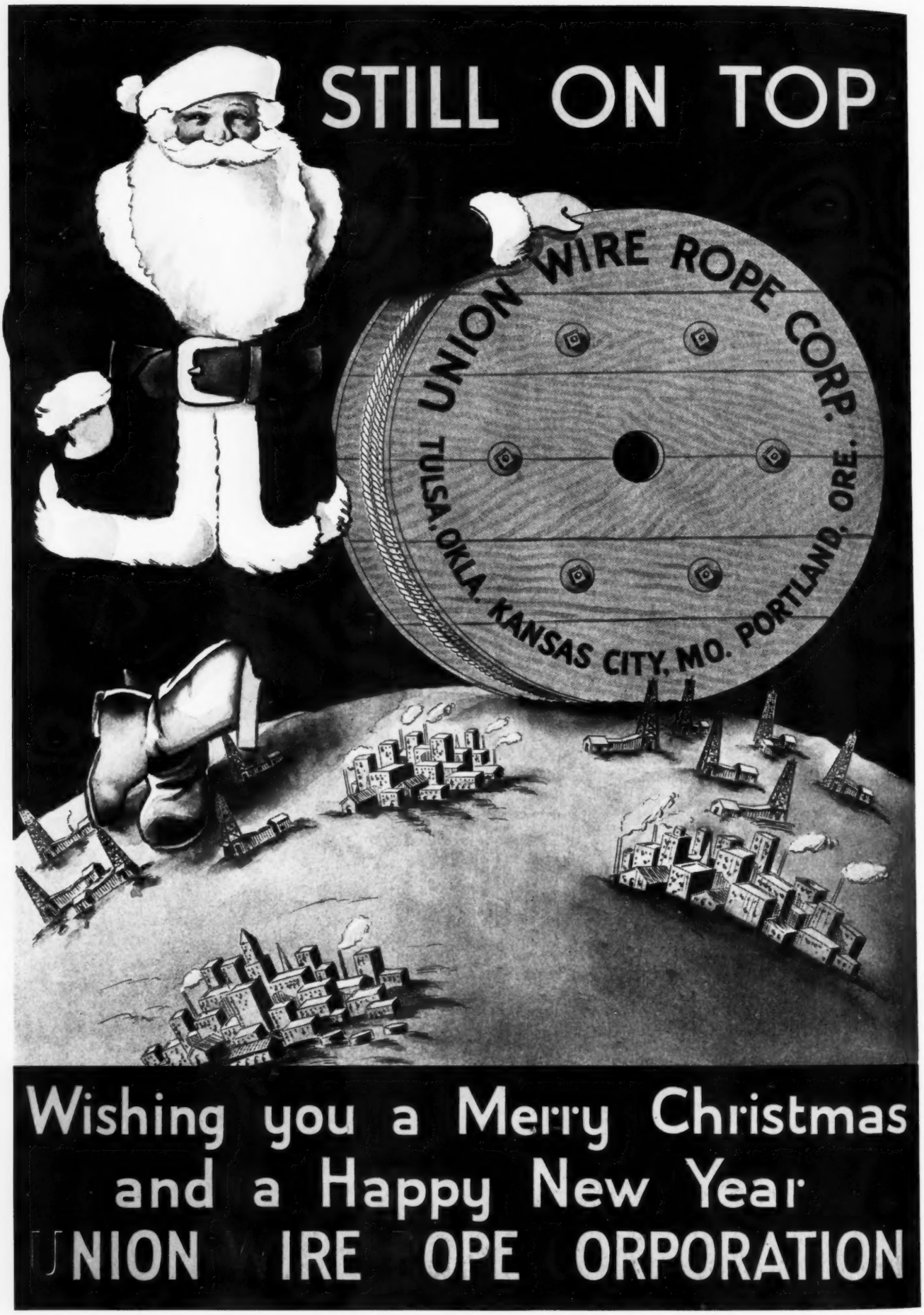
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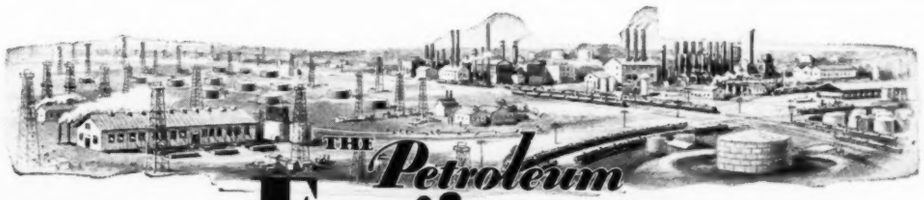

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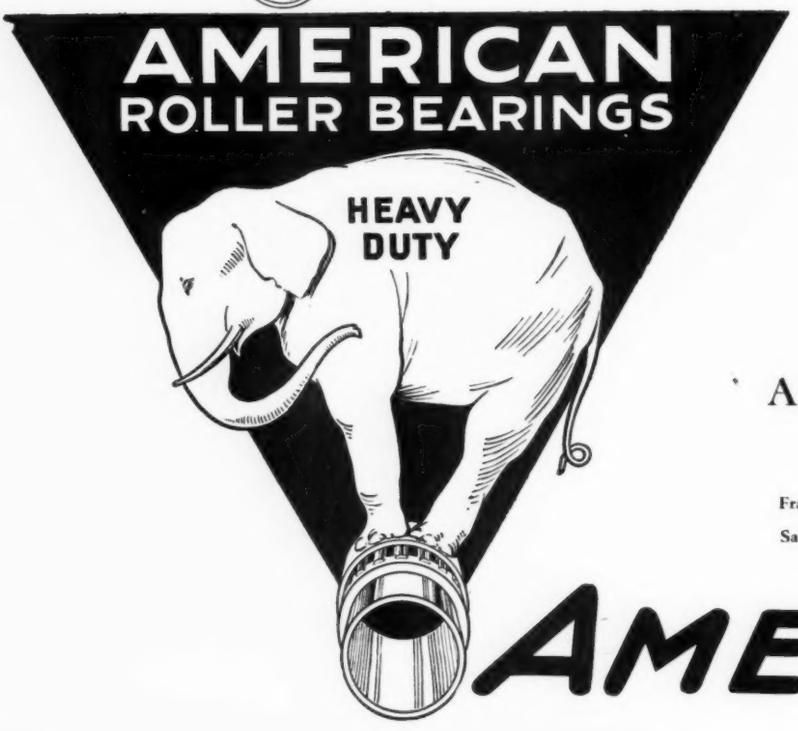

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THE MONTH'S HIGH LIGHTS IN OILDOM

By J. L. DWYER

SEASONAL decreased demand for refined products resulted in the running of some refined products to storage this month. As a result, gasoline prices broke sharply last month in the Mid-Continent and Middle West areas. At this time efforts are being made to get refiners to reduce crude runs to still, which will enable the gasoline market to take care of itself.

Reflection of the refined market condition on crude oil demands from refiners has brought about the placing of a small amount of crude in storage. In the meantime there is talk of making further reductions in crude oil production, which will, if carefully followed by all the Mid-Continent states, keep the crude market "statistically sound." The willingness of a number of companies to replace their crude withdrawals of a few months ago with present priced oil has been an encouraging factor.

For the fifth time since military rule became effective last September 5th, East Texas allowable outlet was cut. The new order allows a production of 100 barrels daily per well and became effective on December 11th. These cuts have been made so as to keep production at 400,000 barrels per day or less. Crude conditions in the field remain steady, with crude storage slightly lower than a few months ago. Crude placed in storage whenever production exceeds 400,000 barrels daily is withdrawn when new proration rules are first made effective, as each new order has dropped production to between 350,000 and 375,000 barrels per day, and it must await new completions before again exceeding 400,000 barrels.

Cold weather has affected the outlet from a number of wells in the East Texas fields because of paraffin troubles and it is likely that increased difficulty will be experienced from this factor during the approaching winter months. Pipe line companies have likewise been troubled by paraffin congealing in the lines.

Drilling in East Texas has shown a slight decrease principally because of inclement weather which has made roads practically impassable, but 15 to 20 wells are being completed daily and on December 12th the area had 3,407 completed tests. Recent estimates on the ultimate per acre recovery anticipated from the region have been materially lower than earlier figures, with some reports placing the amount as low as 10,000 barrels an acre. Decreasing rock pressures in the field indicate that pumping equipment will soon be needed on a great many of the wells to produce the oil.

• • •

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 28, 1931

(Figures in Barrels of 42 Gallons)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	438,000	69.1	4,231,000	10,202,000
Appalachian	91.8	99,500	72.4	1,204,000	1,664,000
Ind., Ill., Ky.	98.9	319,000	73.9	3,437,000	5,852,000
Okla., Kans., Mo.	89.6	235,400	54.1	2,828,000	4,790,000
Texas	91.3	532,400	69.6	6,668,000	11,993,000
Louisiana - Arkansas	98.9	162,700	70.6	1,032,000	4,070,000
Rocky Mountain	89.4	50,200	34.9	1,366,000	808,000
California	97.1	455,400	51.3	*12,919,000	97,060,000
Total Wk. Nov. 28	95.2	2,292,600	62.5	33,685,000	136,439,000
Total Wk. Nov. 21	95.2	2,261,600	61.7	32,511,000	136,264,000
Total Nov. 29, 1930	95.7	2,246,300	62.9	†35,707,000	138,868,000
The Texas and Louisiana Gulf Coastal figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	99.8	412,600	77.6	5,043,000	8,680,000
La. Gulf Coast	100.0	116,400	78.9	876,000	3,264,000

Daily Average Production

(Figures in Barrels)

	Nov. 28, 1931	Oct. 28, 1931	Nov. 29, 1930
Oklahoma	523,850	482,500	486,950
Kansas	104,950	101,900	107,650
Panhandle Texas	56,150	65,050	73,650
North Texas	55,950	57,400	64,350
West Central Texas	26,250	26 950	44,150
West Texas	203,000	192,700	270,200
East Central Texas	56,500	56,250	40,100
East Texas	387,950	400,300	
Southwest Texas	58,950	56,000	78,850
North Louisiana	29,150	29,500	44,200
Arkansas	37,500	37,950	51,900
Coastal Texas	127,500	125,100	161,600
Coastal Louisiana	32,150	27,250	29,350
Eastern (not including Mich.)	107,550	107,100	101,000
Michigan	15,150	11,950	9,000
Wyoming	36,450	39,250	46,300
Montana	7,750	7,750	6,450
Colorado	3,800	4,450	4,200
New Mexico	44,150	43,800	46,100
California	505,400	508,100	599,900
Total	2,420,100	2,381,250	2,265,900

† Revised in Indiana-Illinois district, due to transfer to "Bulk Terminals" of stocks previously reported as "At Refineries."

NOTE: In all the refining districts indicated except California, figures in this column represent gasoline stocks at refineries. In *California they represent the total inventory of finished gasoline and engine distillate held by reporting companies wherever located within continental United States (stocks at refineries, water terminals and all sales distributing stations, including products in transit thereto).

How Important Factors Influence

ABSTRACT

The trend toward co-operative development of oil pools is accompanied with a revival of interest in economic well-spacing, a prime consideration in the economic exploitation of an oil pool. An economic spacing is that spacing which will result in the greatest yield with the least physical waste and greatest economic return. Too few wells in a pool may result in as much physical waste and decrease in economic return as too many wells, hence the need for studying the factors bearing on the problem.

Factors in well-spacing are of two kinds, physical and economic. The physical factors include principally sand and reservoir conditions, while the economic factors include crude price and market demand.

An understanding of the relative influence of the various factors in spacing is essential to an intelligent approach to the problem.

To illustrate how various factors influence the economic spacing, an example has been taken from actual field practice. Curves are plotted of the data to facilitate their study. It is shown that "per cent recovery" and "price" are among the most important factors influencing well-spacing. How increase or decrease of these factors affect well-spacing is also pointed out and discussed. Repressuring, water encroachment, and reservoir conditions in lime areas, are also briefly discussed with reference to their influence on well-spacing.

AS a natural result of the trend toward greater co-operation among operators for the more economical and uniform development of oil pools, interest has been revived in well-spacing. Until recently in the Mid-Continent fields, no real problems of well-spacing were apparent. A standard spacing of one well to ten acres was generally adopted without regard to either the economic factors or physical conditions involved. Lease boundaries and offset requirements were about the only considerations that seemed to govern well-spacing.

From now on, especially in the deeper fields, greater consideration will be given to well-spacing than in the past. The determination of an economic well-spacing is one of the first steps toward the economic development and production of a pool. The problem of well-spacing is one that has been given extensive study, yet from a practical standpoint, comparatively little is known about it. Much excellent work has been done on the mathematical theory of well-spacing, but application of the results of theoretical studies in practice has been greatly hampered by a lack of means and knowledge by which reliable determination and appraisal of the physical underground factors can be made.

Instruments are now available for obtaining bottom-hole data in wells. This type of information, carefully gathered and correlated, will probably play an important part and be a valuable aid in the solution of problems on well-spacing.

It is usually necessary to have data from several wells in different parts of a pool to obtain the necessary information regarding sand and reservoir conditions. Even then, recourse to accumulated data and experience in other pools of a similar nature is sometimes necessary.

In order to see the problem of well-spacing in its true proportions it is helpful to have some idea of the relative importance of the physical and economic factors involved. If we know how these factors are interrelated, and have a general understanding, for example, of what the effect of different assumed percentages of recovery have on spacing, or to what extent changes in the price of crude will affect spacing, the problem can be attacked more intelligently. It is these aspects of the well-spacing problem that will be dealt with in this article.

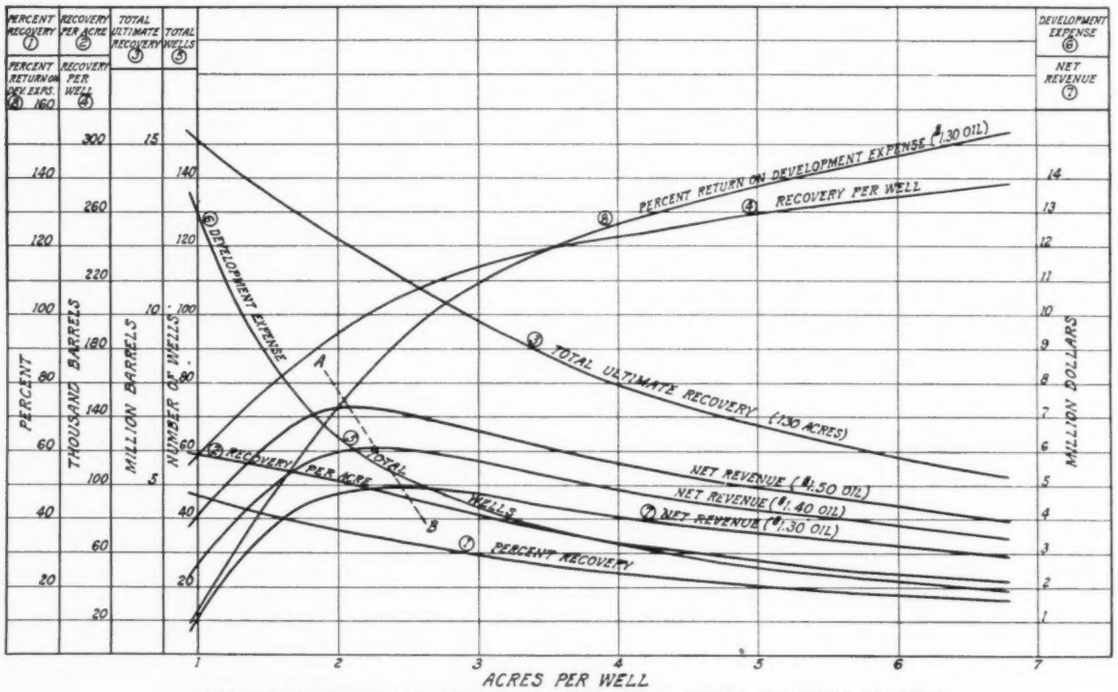


CHART SHOWING INFLUENCE OF VARIOUS FACTORS ON WELL-SPACING

DATA USED IN PLOTTING CURVES

Ultimate Recovery Schedule	12 Per Cent for 1 Well to 10 Acres
Est. Areal Extent Productive	130 Acres
Est. Formation Thickness—Net	120 Feet
Est. Porosity	27 Per Cent
Est. Development Expense Includes Surface Improvements, But Not Lease Bonuses	$100,000 Per Well
Est. Av. Lifting Cost	50c Per Bbl.
Royalty	20 Per Cent
Assumed Price Oil	$1.30, $1.40, $1.50 Per Bbl.
Assumed Price Gas	12c Per M. C. Ft.
Assumed C. H. Gasoline Content	1.75 Gals. Per M. C. Ft.
Assumed Gas-Oil Ratio	1,000 Cu. Ft. Per Bbl.

Economic Well-Spacing

It is obvious that for almost any oil pool of appreciable size there is an optimum spacing for the greatest economic recovery. Such a spacing is an economic well-spacing. Economic recovery is here defined as the greatest recovery with the least physical waste and the greatest economic return. Any spacing greater or less than this may result in physical waste reduced return on the capital investment. It has been said that well-spacing is not so

Well-Spacing

By K. C. SCLATER

much a problem of determining how many acres a well will drain as it is a problem of obtaining the greatest possible yield at a minimum cost. If this be true, it emphasizes the need for using proper discrimination in the use of well-spacing data.

A mass of data bearing on the problem may be painstakingly gathered, and after it is correlated and studied, an appraisal of the different factors made. Great difficulty often arises in giving to each factor its proper weight. There may be a tendency to give too much weight to the physical factors, such as sand thickness, porosity, permeability and saturation and underestimate the importance of economic factors such as probable crude price and probable market demand. Any business venture, no matter of what type, becomes commercially profitable only when the commodity produced sells above the cost of production. There are no exceptions, not even in the oil business. The true significance of price fluctuations in their relation to the well-spacing problem should be understood.

Important Factors In Spacing

Factors that enter into a consideration of well-spacing are of two kinds, physical and economic.

Among the important physical factors are: Areal extent of productive acreage; number, thickness, porosity, saturation, texture, physical character, and depth of oil sands; viscosity of the oil; rock pressure, its magnitude and whether gaseous or hydrostatic; volume gas, free and in solution; gasoline content of gas; surface features including general topography.

Among the important economic factors are: Present and probable future price of oil; present and probable future demand for oil; rate of development; present and probable future methods of recovery; land ownership conditions including amount of royalty.

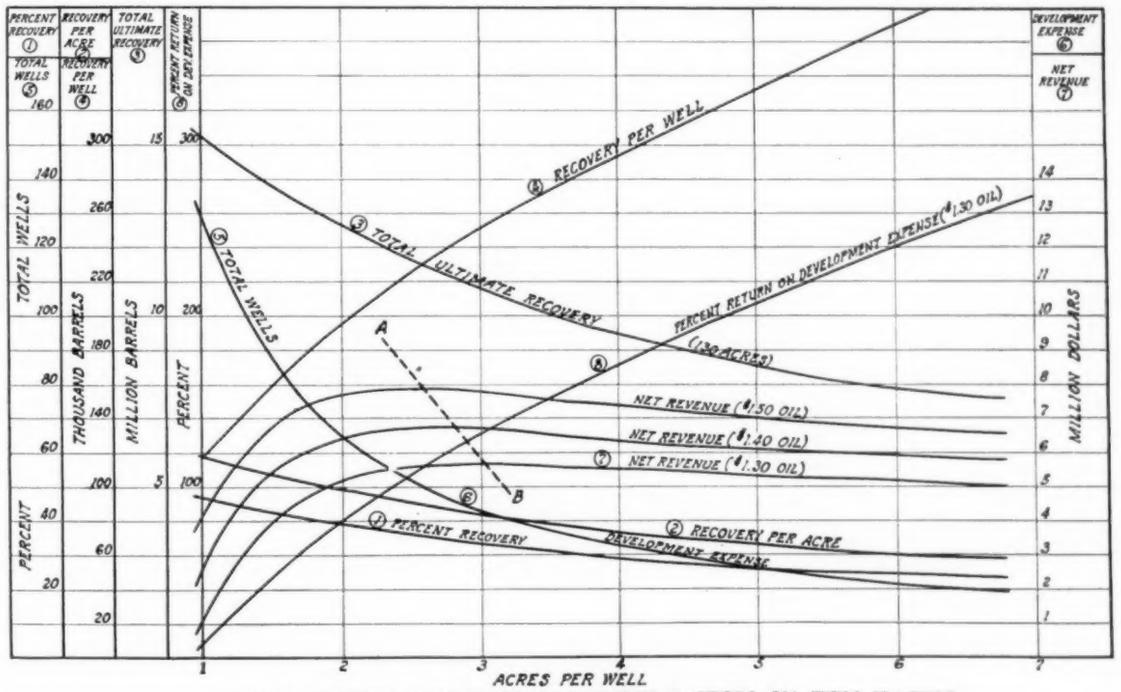
From the physical factors, number, thickness, porosity, saturation, texture, physical character and depth of the oil sands, and rock pressure, an estimate of the total ultimate recovery, per cent recovery at different well-spacings and recovery per acre and per well, can be made, also an estimate of the average lifting cost per barrel.

An estimate of the development expense on a per well basis can be obtained from a consideration of the depth and general character of the sands, the rock pressure, surface features and topography. Also the records of the first wells drilled will be available. Knowing the development expense per well, the total development expense for different spacings can be computed.

From a comprehensive statistical and analytical study of the present and probable future demand, the average price of oil during the life of the pool is estimated. It is advisable also to assume in addition a number of prices above and below the estimated average price. Having the price per barrel, the per cent recovery for different spacings, the lifting costs and investment charges, the net revenue can be determined.

Knowing the net revenue, the per cent return on the total development expense can be figured. One factor of importance that has not been taken into account is the rate of development. This has been purposely left out in order to clarify the discussion of the relative importance of the other factors. The rate of development will modify the rate of revenue return and necessitate a consideration of discount factors.

With this information compiled we are in a position to



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utilize it for a study of the relative importance of each factor, its interrelation with the other factors, and its bearing on the net revenue at different well-spacings.

Influence of Various Factors on Spacing

By plotting the assembled data it is more conveniently studied, as the curves show at a glance the critical limits of spacing. In the two accompanying charts is illustrated a method of plotting well-spacing data that has been successfully used in the solution of well-spacing problems. It is of the very simplest type. The date of development was not considered as it was planned to drill the acreage within a few months. The values of eight factors are plotted on plain co-ordinate paper against acre per well-spacing from 1 acre per well to 6.8 acres per well. The eight factors are: (1) per cent recovery; (2) recovery per acre; (3) total ultimate recovery; (4) recovery per well; (5) total number wells; (6) development expense; (7) net revenue (the net revenue for three different oil prices, $1.30, $1.40, and $1.50 have been plotted in this case); and (8) per cent return on development expense (for $1.30 oil).

Any number of selected factors may be plotted. It will be observed that the two sets of data are alike except that a per cent recovery of 12 per cent for one well to ten acres has been used in one chart and a per cent recovery of 20 per cent for one well to ten acres on the other. The data for the per cent recovery curve for the different spacings as shown was computed by the Haseman method from physical data. Computation of data for this curve may be computed by other methods and plotted on the same chart for comparison and as a check if desired.

The problem of well-spacing seems destined to command much attention in the development of future oil fields; especially Western Kansas. In Mr. Sclater's paper presented at the Fall Meeting, Mid-Continent Section, American Petroleum Institute Division of Production, Drumright, Okla., Dec. 11 and 12, 1931, it is emphasized that detailed study of local conditions rather than any general policy should determine well-spacing.

—Editor

Per cent recovery is probably the most important factor influencing well-spacing, and the data required to plot the curve contain the greatest number of physical factors about which little may be known. For this reason the data for this curve should be carefully checked by several different methods before it is used.

An examination of both charts will show that an increase in per cent recovery tends to flatten out the net revenue curve, and conversely, a decrease in per cent recovery tends to make the point of maximum net revenues more pronounced. Stated in terms of spacing it means that the higher the per cent recovery the greater latitude it gives for varying the well-spacing without causing much change in net revenue. Another interesting fact to note regarding the per cent recovery curve is, that the flatter it is the greater latitude it would permit for varying the well spacing without causing much change in net revenue. As to the physical factors that affect the shape of the per cent recovery curve, permeability is the most important. The tighter (higher permeability) the sand the more curvature the per cent recovery curve will have, hence the more narrow are the limits of spacing permissible for economic recovery, but the greater the permeability of the sand the less curvature will the per cent recovery curve have, hence the greater the latitude within which the spacing can be varied without causing much change in net revenue. Thus does the per cent recovery factor influence the spacing.

In the two charts the net revenue for three prices of crude have been assumed, namely: $1.30, $1.40 and $1.50 per barrel. The line A—B on both charts passes approximately through the maximum point on each net revenue curve. It indicates the trend of maximum net revenue with an increase or decrease in price. As is to be expected, an increase in price favors a closer spacing while a decrease in price favors a wider spacing. Note also from the curves how abruptly the net revenue falls when the spacing is changed from two acres to one acre per well. In this case the increase in per cent recovery with a spacing less than one and three-quarter acres per well is not sufficient to justify the development expense, which rises rapidly with close spacing.

It is not inferred that the trends shown in these charts and curves will apply to any set of well-spacing data, as this will depend largely on sand and reservoir conditions.

An analysis, by the use of charts, of the effects of the different factors on spacing can be carried to any length desired or warranted by the amount and accuracy of the data available.

There are other factors influencing well-spacing, that are combined in the curves of total ultimate recovery and per cent recovery. One is the net thickness of the producing sand. It is so obvious that it seems almost unnecessary to state that, in general, the greater the net thickness of producing sand, the closer the spacing for the greatest economic recovery.

One of the most elusive factors is water encroachment. It is a factor that frequently cannot be readily evaluated. However, if all operators in a pool co-operate in a well-ordered plan of development, water encroachment can be controlled and the per cent recovery increased. What might have been a menace is thereby turned into a profitable factor.

Another elusive factor is the very irregular porosity such as is found in lime areas. Very irregular porosity is often accompanied by high permeability. This is a bad condition if edge water is present as the control of the latter is difficult. High permeability means high per cent recovery, which means closer spacing for economic recovery, providing of course, that water encroachment can be controlled.

The subsequent repressuring of a pool usually will result in an increased per cent recovery, hence will favor a closer spacing than were no repressuring methods used. This in general would hold good only if the repressuring were carried on at a pressure lower than the original rock pressure. Were subsequent repressuring of the sand carried on at a pressure higher than the original rock pressure, closer spacing than that necessary when the pool was first developed would not probably be warranted.

Sometimes the probability of deeper producing horizons in a pool is great enough to give it some weight in favor of closer spacing.

As potent as is the economic factor, price, in the well-spacing problem, it does not admit of much analysis in a determination of the probable future price. There is no consistent relationship between the cost of producing a barrel of oil and its selling price. The best that can be done is to make a keen statistical study of the probable future demand. A better balance between supply and demand should prevent violent price fluctuation and make possible a better determination of probable future price.

Natural Gasoline Plants in East Texas

By F. R. STALEY

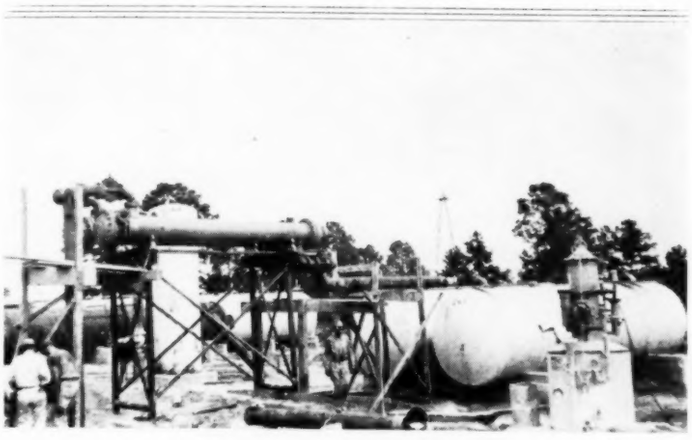
THE Humble Oil & Refining Company, the largest operator in the East Texas field, has recently completed two compression plants which are the first natural gasoline plants to be erected in this area. Many operating companies have investigated the possibilities of the field during the past year with a view of erecting gasoline plants, but only with the results that the project was either postponed or abandoned due principally to the low market prices existing for gasoline, even though the available gas is sweet and rich in gasoline, yielding an average of four to five gallons per 1000 cubic feet. Although natural gasoline is produced in the Humble plants they were built primarily as gas conservation plants.

The first Humble plant has a capacity of ten million cubic feet of gas per day and is located at London, Texas. The second plant, located at Kilgore, has a capacity of five million cubic feet.

The gas for the plants is collected from the various leases in a carefully designed gathering system; the capacity of each line was carefully calculated by the company engineers. In each plant the gas is compressed in three stages to a final pressure of 1,500 pounds per square inch, where gas is to be returned to the reservoir. The gas is compressed to 35 pounds in the first stage, and to 300 pounds in the second stage at which gasoline is recovered.

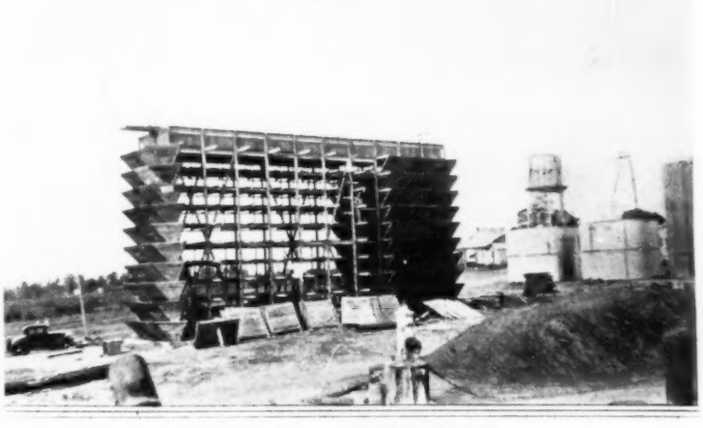
The London plant contains 26 units, as follows: 17 100-h.p. single units, five 200-h.p. twin units, two 200-h.p. double acting units, and two 165-h.p. units.

The Kilgore plant contains 12 units, as follows: eight 160-h.p. twin units, two 85-h.p. single units, two 80-h.p. single units.



High stage condensers, Kilgore.

Compressors at Kilgore plant.



Cooling tower construction, Kilgore.

The operation and layout of the two plants are similar. The gas from the low stage compressors in each plant is cooled in two horizontal tubular condensers. Two 7x29-ft. horizontal tanks are installed as gasoline accumulators. Two tubular condensers set vertically are used for the second stage of compression, and two 6x40-feet horizontal pressure vessels are used for accumulators. These are made of 1-inch plate, with riveted lap joints.

A stabilizing unit will soon be installed in the London plant to treat the gasoline produced in both plants. Raw gasoline will be transferred from the Kilgore plant by pipe line. Since the gasoline is sweet, no treating plants are required.

A large redwood cooling tower is installed in each plant for cooling the water from the coolers and compressors. Abundant water is available at each plant, produced from shallow wells.

Steam pumps are used for handling both gasoline and water in both of the two plants.

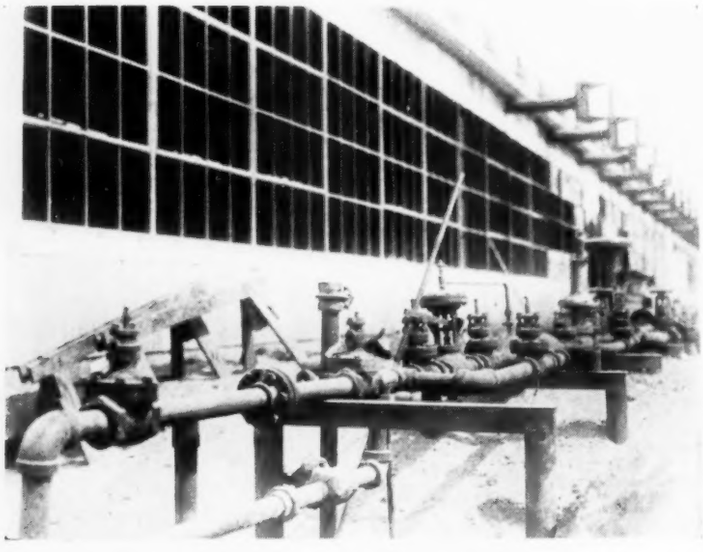
The boiler house in the London plant contains six 85-h.p. field boilers which are gas fired. The Kilgore plant has two 66-h.p. boilers. The installations are very modern and compact. Automatic control devices are used for gas and level control.

All of the buildings in the plants, including compressor rooms, boiler houses, pump rooms, etc., are constructed of steel and corrugated metal with concrete foundations. They are well lighted and ventilated.

In the East Texas field the gas-oil ratio, that is, the volume of gas produced per barrel of oil, is relatively small, the average for the field

Welding at Kilgore plant.

High-pressure accumulators, London, Texas.



Manifold at London, Texas, plant.

approximating 300 cubic feet per barrel. On top of this, the daily allowable per well has been drastically curtailed. At this writing it is 100 barrels, and if the field allowable has to be kept within 400,000 barrels daily for some time, it now appears a certainty that the daily allowable per well will be even lower than this.

Also taking into consideration the fact that as the rock pressure diminishes, many of the wells will be put on the pump and paraffin trouble will begin to make its presence felt. This will mean that a certain percentage of the wells will be off production daily. With all these factors the question of obtaining a stable supply of casinghead gas of sufficient volume is a formidable problem. These factors have been responsible for retarding the installation of casinghead plants in the field. At present it is difficult to justify the installation of plants for the manufacture of casinghead gas alone.

Here it can be said that the Humble Oil and Refining Company has taken a forward step. From accurate data obtained from their repressuring operations in the Sugarland field, Raccon Bend and other isolated areas, they have been able to evaluate the possibilities of the plant as repressuring units in terms of probable increased ultimate recovery. By the application of sound engineering principles based on actual operating experience, this company has paved the way for putting into practice what they know to be no experiment, but production methods, the economical results of which will be far reaching.

Much credit for the adoption of the advanced plan of operation is ascribed to the close co-operation among the different technical and field staffs within the production department of the Humble Oil and Refining Company.

Recently the Gulf Production Company has arranged to erect a five million cubic feet plant in Rusk County. The residue gas will be compressed and used for repressuring. A plant is also under construction in the Joiner field, and one is planned for the Gladewater district. It is quite probable that as the field rock pressure declines and the production falls that repressuring will be resorted to in order to increase production and hold up the wells to a high daily rate. When the general economic conditions improve and the price of natural gasoline increases there will no doubt be greater interest given to the possibilities of repressuring, and more plants constructed in the East Texas field.

The U. S. Bureau of Mines figures show a substantial decline in natural gasoline production in this country during the past year. During the month of September, 1931, the production was 1,090,476 barrels less than during the same month of last year. California is the largest producer, followed by Texas and Oklahoma. In 1930 these states produced 87 per cent of the total production.

Over 90 per cent of the natural gasoline production of the country is used by refiners for blending motor fuel in order to give the proper volatility to this product. The large increase in the number of cracking units installed in refineries during the past year for the purpose of improving the anti-knock rating, or in other words, the octane number, has resulted in demand for the most stable grade of natural since the cracked distillate differs from the gasoline straight run from the crude.

New Welding Method Speeds Line Construction

By J. H. DAMERON

Making a bell hole weld.

TO attain welding speed with economy in the construction of approximately 360 miles of loop work on its line from Mid-Continent to Chicago, Illinois, the Stanolind Pipe Line Co. is employing a new method of welding in the field in connection with a relatively new welding technique. Both the method of making the firing line welds and the welding technique make for speed.

The pipe is lined up in five-length sections on dollies and tack-welded by the line-up crew. The firing line operation is new, in that one welder makes all four welds in each section. Two welders work from each generator, which is set approximately at a center point between the two sections, operating from the generator which is equipped with two sets of long hose. The new Lindeweld technique is employed, with a rod specially developed for the process used. This technique calls for the welder to employ an up-and-down motion of the blow pipe flame, playing the flame up on the rod and down on the vee, which is a contrast to the ripple weld method, wherein the flame is played back and forth across the vee.

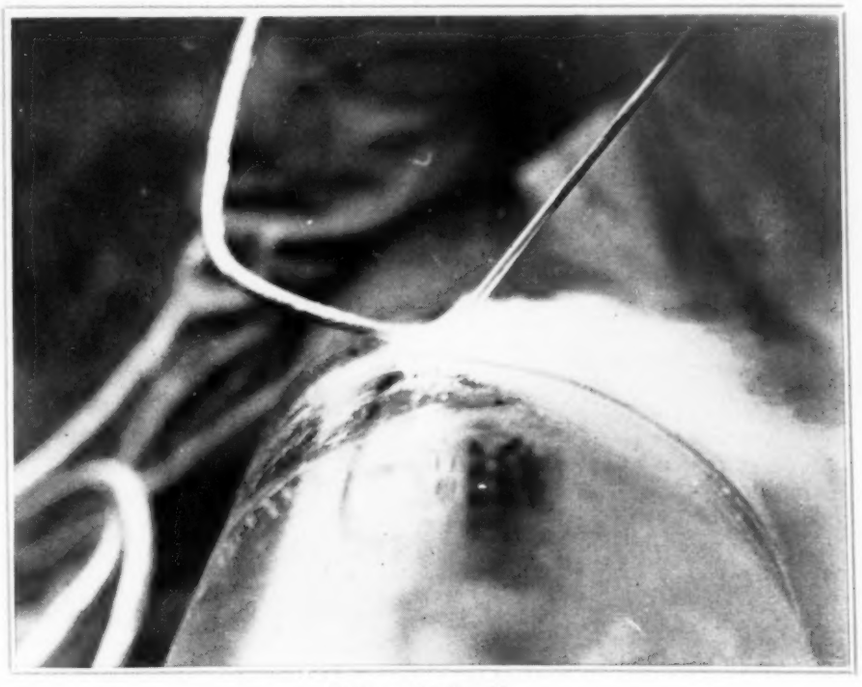
Pipe used in the construction of the loops is 10- and 12-inch diameter pipe with a wall thickness of $\frac{1}{4}$ of an inch. It was shipped in random 40-foot lengths and the construction work spreads in sections from Oklahoma to Chicago, Illinois.

Obtaining first-class welds was of paramount importance to the transporting company, and to this end only qualified welders were employed. These were selected from welders who passed a qualification test before being employed on any welding. To pass this test the firing line welders were required to make a roll weld and the bell hole welds. After a welder had made his qualifying weld a portable tensile testing machine was used to test the welds for tensile strength. Four coupons, equally disposed around the pipe circumference, were cut from the qualifying weld and tested with the machine. Requirements were that each coupon should fail in the pipe and not in the weld. If the coupon failed in the weld, the welder did not qualify.

After qualifying, the welders were further coached in the technique to be employed in making the field welds. Particular attention was given to the adjustment of the flame, which called for an excess of acetylene amounting to not more than one-half of the inner cone flame length, and in some cases a barely noticeable excess was used.

The included angle of the bevel was 74 degrees and the weld was started after the parent metal and the rod had been heated preparatory to welding. With this method the weld was burned in $\frac{1}{32}$ of an inch in the walls of the pipe and when completed it is narrower than a standard ripple weld and not more than $\frac{1}{8}$ of an inch high.

Each firing line welding crew was aided by a pipe line company inspector and usually by a welding equipment service man. They observed the welders at work and offered assistance in welding technique and checked the appearance



Close-up of roll weld.

Ditcher going through flat country.

of the welds. The chief welding inspector made periodical visits to each firing line and the bell hole welders and made tests of their work.

Equipped with a stencil, each welder stamped his number in each weld as he completed it, so that it could be readily identified. The chief welding inspector made periodical inspections along the firing lines, cutting out a weld occasionally on each welder for test purposes. Four coupons from each weld cut out were tested with the tensile testing machine.

Usually this machine is carried in the car in which the chief inspector travels over the line. Sometimes, however, welds are cut out and sent to the nearest shops for testing. In the early stages of the construction work the chief inspector's schedule was arranged so that a test of each welder's work was made every three or four days. Later on the schedule was changed so the check was made about once each week. In checking th work of all welders the same tensile requirements were used, but each welder was permitted to have one coupon of the four tested, fail in the weld without being disqualified.

The method of operating the firing line gangs differs widely from the commonly-used method of operating four torches from one generator and making the four roll welds in one section with a single roll of the section. On this work only two welders operated from a generator and each of these welders made all four roll welds on each section. Each generator is equipped with lengths of hose and when the firing line moves up the generator is set about half way between the two sections, comprised of five lengths of 40-foot pipe. One welder and a helper are assigned to a section and the helper starts rolling the pipe slowly as the welder starts the roll weld. Upon completion of the weld he moves to the next joint, and so on until all four welds have been completed.

By using this method more uniform welding was attained, along with a substantial increase in welds per welder per day. In speed welding on such diameter pipe it is difficult for two or more welders to maintain the same welding speed, because one may lag behind the others for various reasons. That welder may speed up on the next weld, but someone else may lag and slow down the over-all welding time. On larger diameter pipe the welders have more latitude and should one lag a little he may catch up or finish a little behind the others without delaying the remaining welders. On the 10-inch pipe a roll weld is made in nine to ten minutes, and on the 12-inch eleven to twelve minutes are required.

The pipe is lined up by a line up crew who set it on dollies where it is tack welded at each joint with three small tack welds. The pipe is lined up and tacked on dollies as an economical measure. It helps to speed up the work and more important it assures more perfect alignment and the maintaining of the alignment during the welding.

When lined up on skids it may be brought in satisfactory alignment but during the roll weld the section will not hold in alignment should part of the skids be resting on a rise or depression in the ground. When this condition prevails a stress is sometimes set up on the welds before they have cooled.

The dollies are made with case iron roller operating in channel iron supports. They are light and easy to handle and make it possible for the welders' helpers to rotate the pipe with greater ease and more smoothly. After the welded section has been removed from the dollies they are gathered and hauled on ahead in one of the trucks.

The bell hole welders use the same welding technique that is used in the roll welds and make almost as good speed. Such a weld on the 10-inch pipe averages about eleven minutes and about 14 minutes on the 12-inch pipe. On an average, about 1.4 pounds of rod is used to make a weld on the 10-inch pipe and about 1.7 pounds on the 12-inch pipe.

By maintaining close control on the welding of the joints the pipe line company's construction engineers have been obtaining excellent results. This is borne out by the initial test on many of the sections. Some have been tested with air without any leaks developing. On these tests only 100 pounds of pressure could be built up on the line because facilities were not available for a test with higher pressure built up without any leaks developing. In addition the welding work progressed with more speed and the two together made for greater economy in construction.

Bell hole welders tying in line.

World's Tallest Derrick Erected in Ventura Avenue Field, California

By W. A. SAWDON, *Petroleum Engineer, Los Angeles*

SUPERLATIVES are still being maintained in the Ventura Avenue Field, California. With the world's deepest commercial producer here located, the tallest derrick in the world, shown on this month's cover of THE PETROLEUM ENGINEER, and some of the heaviest equipment yet used for rotary drilling have now been installed. These advanced designs are being used by the Superior Oil Company on its Hartman lease and they will undoubtedly contribute valuable data on the best methods adaptable to deep drilling.

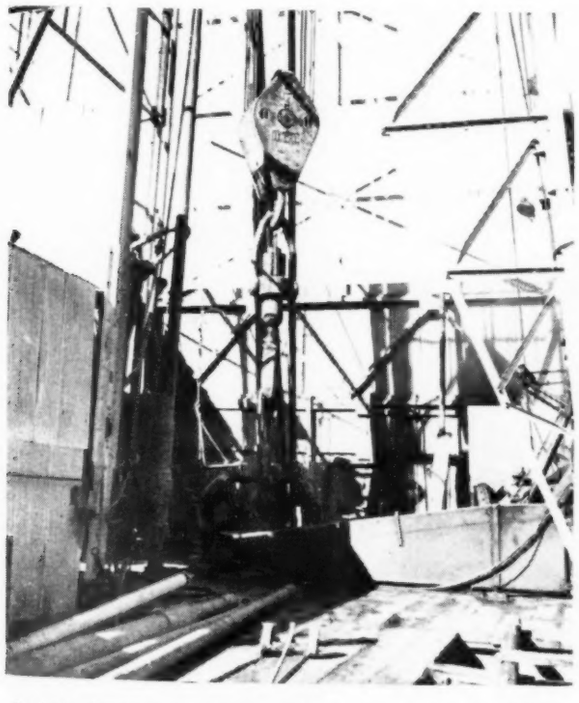
The derrick is a reinforced steel Ideco, 178 feet high, built to A. P. I. specifications. It has a 32-foot base, which allows for extra stands of pipe as well as providing the proper inclination as necessitated by the greater height. The overall dimension from the foundation to the top of the gin pole is 194 feet. Designed for extra heavy wind load, it has a capacity of 1,000,000 pounds.

Several unusual features have been incorporated in the design of the derrick, which, together with the foundations and steel substructure, were made by the International Derrick and Equipment Division of International-Stacey Corporation. The piers have been so planned that the 178-foot superstructure can be taken down and replaced by a regular 122-foot derrick with a 24-foot base. This has been accomplished by placing two sets of foundation bolts in the piers, with the piers themselves extending toward the center to provide the bearing surface. Also, the derrick is built with a 30-foot window, which allows extra long lengths of pipe to be dragged in to the derrick floor.

The side hill location necessitated the placing of the 5 boilers some distance below the well.

The mud pumps, of which there are two, are Ideal 14½x7½x18 and are located below the derrick floor in the house shown in the lower foreground. The water ends of these are tested to 3,000 pounds. Immediately in front of them can be seen the mud tank and beyond and above it the settling ditch.

Returns from the hole are passed over two Lemco vibrating screens. While satisfactory results could probably be obtained with one of these screens equipped with 30-mesh,

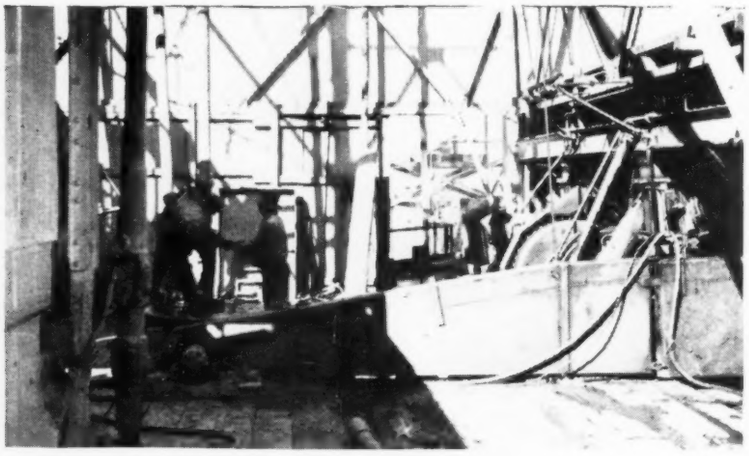


A 30-ft. window allows long lengths of pipe to be dragged into the derrick.

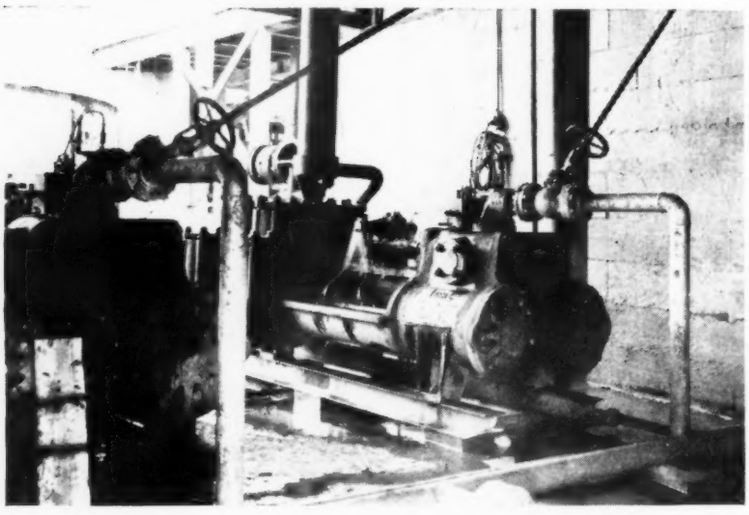
The piers are designed to take a 24-ft. base derrick after the 178-ft. x 24-ft. derrick has been removed. 28-inch I-beams are supporting the floor loads.

the company favors the use of two screens with 40-mesh material. The system used for diverting the mud equally over both screens is shown in one of the pictures.

The rotary table is an Ideal No. 12-25½-inch and is driven direct from a sprocket on the jack shaft. The drawworks is an Ideal 34-9-3 and was designed primarily to meet the demand of a larger engine and the tall derrick. It provides four hoisting speeds; and line speeds of from 460 to 2,400 feet per minute in four progressive steps are thus available. These speeds are figured on a rotative speed of the engine of 250 r. p. m. The drum is 26 inches in diameter and is grooved for 1¼-inch line with a distance between flanges of 46 inches. The drum shaft, line shaft and jack shaft are made of forged steel 9 inches in finished diameter and they all rotate on heavy duty roller bearings.



Here can be seen the drawworks with the guarded rotary table drive.



The mud pumps are located below the derrick floor elevation, but are controlled from above.

The mud passes through two vibrating screens before entering the settling ditch.

Safety guards are used over all chains and exposed gears, while weight indicating instruments and all other late features are incorporated to facilitate operations. The brake-operating mechanism is the type "K" design. The weight of the complete drawworks, including chain and guards, is approximately 36,000 pounds.

The prime mover is a twin Ideal-Ajax, 14x14 roller-bearing engine. Its design is very similar to that of the 12x12, but it is of much more massive construction. The crankshaft is 7 inches in diameter. Yet the use of much larger sprockets has been made possible because the distance from the center of the shaft to the bottom of the base has been materially increased over the 12x12 engine. The Timken roller bearings used on the crank are made with a special provision for adjustment and locking. All working parts are totally enclosed and lubrication (except for cylinders and valves) is by the splash system. Provision is made for removable inspection plates to allow for speedy adjustment of all parts requiring attention. The total weight of the engine is approximately 28,000 pounds.

The wire line—3,000 feet in length—is made of 1¼-inch diameter improved plow steel. The crown block was designed primarily for this size line and is of the Ideal "SC" type. It is the latest development in cross-over sheave construction wherein extreme ruggedness and simplicity of design have been combined. Structural steel members are used exclusively in the frame construction to insure maximum strength. The four upper-deck sheaves are made of manganese steel 48 inches in diameter and rotate on roller bearings around a 9-inch diameter stationary shaft of heat-treated alloy steel. The two cross-over sheaves are made of manganese steel 30 inches in diameter and rotate on roller bearings around a 5-inch diameter shaft. All sheaves are grooved to A. P. I. specifications for 1¼-inch line and the block is rated at 350 tons safe working load. Its weight, complete, is about 11,000 pounds.

The traveling block, which can be seen in one of the illustrations with the elevator just being unlatched after running in a stand of drill pipe, is a 76-inch, 5-sheave type, grooved for 1¼-inch line. Other derrick equipment includes a 3-inch, 45-foot, 6-joint Champion and Barbour steel rotary hose; Ideal 6-inch rig irons; Ideco calf-wheel; Ideco bandwheel; 12x12 single Ideal-Ajax engine, and Emsco 5¼-inch by 10 chain drive.

The boiler plant consists of five 125-horsepower boilers with a working pressure of 250 pounds. These are located down the slope to the left of the picture of the well and are shown from the outside corner of the settling ditch in another illustration.

The Fractionation *of* Heavy Oils

ARTICLE IV.[1]—Control

By W. L. NELSON[2] *and* DR. MOTT SOUDERS, JR.[3]

ACCURATE control was not important in the early processes for refining petroleum. The early shell still distillation was usually a batch process from which a single overhead product was taken. Since specifications were not rigorous, a system of manual control relying on the practical judgment and skill of the operator was quite satisfactory for the production of the commercial product then desired.

It was not until the advent of the pipe still and the continuous processing of petroleum, accompanied by the demand for uniformity of product, that continuous automatic control became an important problem to petroleum engineers. During the pioneering stage of development, control instruments developed weaknesses in application which strengthened the opposition of many practical operators to all forms of automatic control. During recent years, however, automatic control mechanisms have been greatly improved in ruggedness and reliability and have now attained almost universal acceptance. In many plants the operation of automatic control is so satisfactory that the operator is hardly more than an attendant for the adjustment of instruments.

This is the fourth of a series of articles by the authors on the Fractionation of Heavy Oils which has been published by The Petroleum Engineer. The subject was treated clearly and comprehensively. In an early number, W. L. Nelson will discuss the subject of vacuum distillation.

—*Editor.*

Purpose of Control

The fundamental purpose of control is the production of uniform products that will meet commercial requirements. The continuous production of uniform products requires that the entire plant be in balance and operating under constant conditions. Any fluctuation in the operating condition requires a control adjustment, either manual or mechanical, to restore the balance. The immediate function of control, therefore, is to provide compensating adjustments for relatively minor and unavoidable fluctuations in operating conditions. Usually the properties of the products may range between limits and the control may allow the operating conditions to fluctuate over a corresponding range. The control is usually considered adequate if the total product produced during several hours of operation meets specifications.

Effect of Varying Conditions

Controlling a process is not a simple problem because of the interdependence of the conditions of operation. Control of one variable when the others are constant, such as top temperature, pipe still outlet temperature, or charge rate, would be relatively simple, but since these variables are interdependent and all are subject to variations, controlling one of them is inadequate.

As an example of the effect produced by a varying condition, assume that a top temperature controller is installed for the purpose of maintaining uniform streams of gasoline and kerosene. Should the temperature of the feed decrease, the kerosene would not be completely vaporized, and if the normal quantity of the side stream product were to be collected from the tower under the new conditions, part of the gasoline would necessarily be included in the kerosene cut. Likewise, should the rate of charging increase, feed input remaining nearly the same, the pipe still outlet temperature would decrease and again the kerosene would not be completely vaporized. If heat exchangers are included in the system, the effect of a varying condition becomes even more involved, because a time lag exists between the change and the results.

In actual operation not one but many of the variables may be simultaneously out of control. Uniform operation can be obtained only by considering and controlling the entire processing operation as a unit.

Hunting

One of the most important factors in the control of the continuous process is the judgment of the operator (whether human or mechanical) in deciding the extent of the adjustments which must be made in order to bring a wandering condition back to normal. The operator should be able to anticipate the final extent of the deviation and correct for it before the final results are recorded on the instrument. In an instrument this is equivalent to the ability of the mechanism to follow automatically the trend of the deviation. Since the operator has no sure means of knowing where an operating condition will finally stand constant, except by waiting, he is likely to overestimate the magnitude of the required adjustment and find after a time that the condition is out of control in the opposite direction. Therefore, the skillful operator or good automatic control makes small adjustments, except in emergencies, and waits until the effects of one adjustment can be gauged before making another. If such a procedure is not followed, the phenomenon of "hunting" occurs or the operating condition wanders above and below normal. It appears that the ability to recognize the trend is of even more importance than the accuracy with which the adjustment of the condition is made.

[1] **I—Fundamentals**, The Petroleum Engineer, Sept., 1931, p. 83.
II—Heat Balances and Tower Temperatures, The Petroleum Engineer, Oct., 1931, p. 131.
III—Number of Plates and Diameter of Column, The Petroleum Engineer, Nov., 1931, p. 98.

[2] Professor of Petroleum Engineering, University of Tulsa.
[3] Consultant Engineer, Ann Arbor, Michigan.

Variables Susceptible to Control

Probably the most important independent variables affecting the control of petroleum distillation units may be included under:

1—Pressure in the fractionating tower.

2—Quantity, temperature and composition of the feed material.

3—Quantity of each of the products.

4—Heat input.

The major dependent variables may be regarded as:

1—Temperature of the pipe still outlet.

2—Temperature of the overhead and sidestream products.

3—Quantity of reflux supplied.

In general a successful system of control consists in maintaining the independent variables as nearly constant as possible and compensating for minor fluctuations by adjustment of one or more of the variables which are susceptible to direct control. Essentially such a method of control requires an actuating variable, the deviation of which causes the mechanism to adjust the variable which has been selected for direct control.

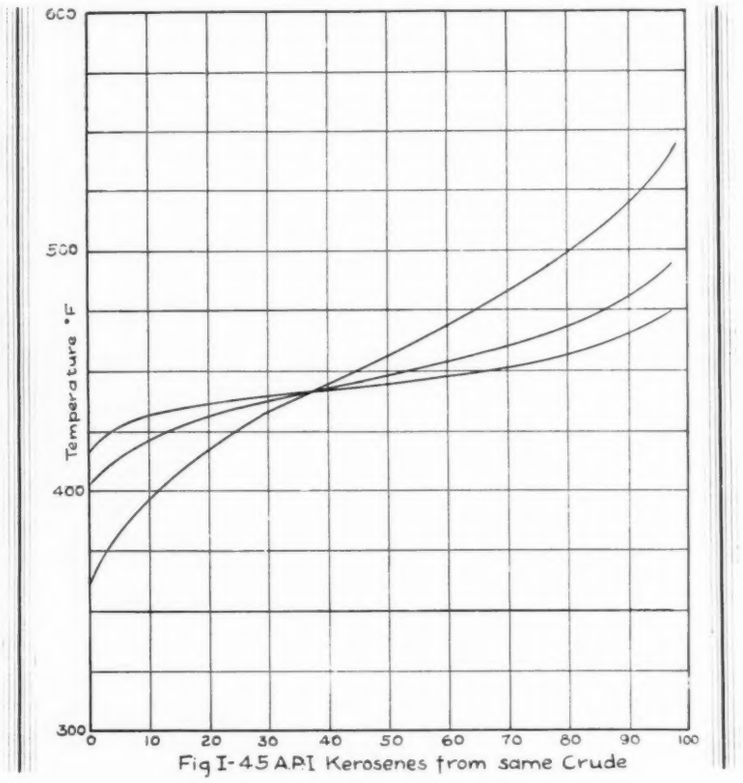


Fig I-45 API Kerosenes from same Crude

Usually the pressure in the tower is controlled independently and is maintained constant regardless of fluctuation in the other variables. Composition of the feed material is beyond the control of the operator and minor variations in it must be compensated by the control of other variables. The quantities of the feed and the products are usually maintained nearly constant. Constant charge rates are obtained by placing an orifice in the discharge line when using a centrifugal charging pump, or by using dry steam and a stroke regulator with a positive pressure charging pump. Constant quantity of side stream product is usually obtained by manual adjustments of a draw-off valve or such a device as a proportioning weir box.[6] The heat input to the still is usually controlled by regulating quantity of the fuel fired to the still.

Since the basic purpose of control is the production of uniform products, the actuating variable of the control operation should be related as directly as possible to the properties of the product. Hence we find that side-draw control is usually governed by periodic laboratory tests of the side-draw products, although direct control may be exercised by the temperature of the draw-off plate. In a distillation process at a constant feed rate and constant pressure the draw-off temperature of a product is a function of the reflux quantity and the composition of the product, and therefore temperature is the usual actuating variable in the control of fractionating equipment, and the fuel fired to the still or the reflux quantity or both are usually the variables subject to direct control.

Top Temperature Control

Since the overhead product is subject to the most rigorous specifications, the temperature at the top of the fractionating column is now generally regulated by automatic control. A constant top temperature is doubly important because it regulates the temperature gradient in the rectifying section of the tower and governs the endpoint of the overhead product as well. Actuation is obtained directly from the temperature of the vapor above the top plate of the tower. Variations in this temperature act through a suitable relay system, upon a motor-operated valve in the reflux delivery line. Increase in the top temperature serves to open the valve, which provides a larger quantity of reflux, which in turn reduces the top temperature. Decrease in the top temperature closes the valve and decreases the quantity of reflux. The control point in the vapor above the top plate is selected because it is sufficiently anticipatory, because it is not affected by sudden changes in the temperature of the reflux, and because an instrument recording the top temperature must usually be provided in any case. Theory indicates that regulation from some point below the top or vapor line might be desirable because variations in the quantity of reflux that will be required during the next few minutes of operation are reflected from lower points in the column. However, the selection of the proper control plate is difficult and a control point too far distant probably would result in hunting. Experience with top temperature control indicates that the control point should be in the vapor above the plate rather than in the liquid on the plate, and that a constant vapor temperature may be maintained with this control point, even though the temperature of the top plate may wander slightly.

Excess-Heat Tower-Control

If only two products are to be produced—that is, an overhead product and a bottoms product—the properties of these products may be controlled satisfactorily by only a top temperature controller. In operating with this single control the heat input to the tower should be increased by approximately 5 per cent more than the heat input required for complete vaporization of the overhead product. If provision were not made for this excess heat, the control would fail of its purpose should the charge rate or the heat input decrease. A failure would occur because the overhead product was not completely vaporized—a condition which is beyond the reach of the reflux controller. When the excess heat is provided, the reflux heat and the reflux quantity may

decrease as much as 5 per cent of the heat input to the tower before the controller fails to function. This range of variation is usually adequate for the normal fluctuation in operating conditions. This method of control, which may be called the "excess-heat tower-control," is particularly satisfactory if the feed rate and heat input to the column are maintained reasonably constant.

The excess heat required in the operation of this control system appears, superficially, to add to the cost of processing. In actual practice, however, the control system, by virtue of smooth operation, eliminates other heat losses, which are often greater than the 5 per cent of excess heat required. Furthermore, this system of operation supplies more than the minimum quantity of reflux, so that better fractionation results and larger yields are often obtained.

In towers taking off side streams as well as an overhead and bottoms product, provision for supplying excess heat, although desirable, is not necessary for the successful operation of the control mechanism. In such a column ordinary fluctuations in operating conditions would not result in failure to completely vaporize the overhead product. The product drawn immediately above the vaporizer is most affected by variations in the operating conditions, but since the product from this plate, or those situated low in the column, is usually not closely limited by specifications, small variations in the quantity or properties of it are usually ignored.

Side Draw Control

Under constant conditions the temperature of the plate from which a product is withdrawn is a function of the composition of the product and therefore is related to the endpoint of the product. The initial boiling point of the product, however, must be controlled by the use of an auxiliary steam stripping tower which removes the light ends. Plate temperatures may be controlled by the use of a controller similar to the top temperature controller. For side products this control would actuate the draw-off valve rather than the top reflux valve. As the valve is opened, the proportion of the internal reflux which is removed as product increases and both the temperature of the plate and the endpoint of the product increase and *vice versa*. Practically, there is little use for side-draw temperature control, because relatively few multiple-draw towers are in operation and usually the properties of the side products are not as closely specified as are the properties of the overhead products. However, such a control would be useful in operating towers having as many as four side-streams. Control of the product, subject to the most rigid specifications, would greatly simplify the manual control of the other three.

Adjustment of the quantity of side products may be made manually at towers by adjusting the draw-off valve, or at the instrument board by "piping" the product line through the control room. Notched plug-cocks, actuated by a worm gear and wheel, are suitable for fine adjustment of the flow. De Florez[8] has suggested the Selsyn remote control mechanism for operating valves at a distance. Two synchronized motors energized by the same excitation current form the basis of this mechanism. As the rotor of one motor is turned at the instrument board, the other motor at the plant responds and turns through the same angle.

Proportional Draw-off Weir

In multiple-draw towers the internal reflux either passes the draw plate as reflux on its way to the plate below, or is withdrawn as a side product. Under normal operating conditions the ratio of reflux to product is a constant, provided the temperature of the feed to the column is maintained constant. The constancy of this ratio provides the basis of the proportional draw-off weir[6] which, after a single setting, will maintain a constant proportion between product and internal reflux. Essentially the device consists of a weir box through which the entire reflux from the plate above the side draw plate flows. Behind the weir is a movable partition which may be adjusted from outside the tower. The reflux flows into the space on one side of the partition and the product flows into the other.

Pipe Still Control

Pipe still control involves the regulation of two factors—the feed rate and the heat input. The relationship between these factors determines the temperature of the oil leaving the still and the control mechanism usually attempts to maintain a constant pipe still outlet temperature. In most pipe still control systems, provision is made for maintaining a uniform charge rate and adjustment of the heat input is obtained by manually controlling the fuel fired to the still. The actuating variable may be either the temperature of the oil leaving the still or the temperature of the furnace cavity, or both.

The maintenance of a constant outlet temperature of a pipe still is a difficult problem. Most troublesome is the time lag between the moment when the fires are adjusted and the moment when the outlet temperature reacts to this adjustment. Superficially, the temperature of the furnace cavity appears to be a logical anticipatory control point. Doubtless it is an anticipatory point, but the necessity of compensating for the time lag complicates the control. Moreover, a control thermocouple in the furnace cavity must be carefully located in order to avoid direct radiation from the flame.

If the fractionating tower is equipped with (1) a top temperature controller, (2) proportioning weirs, and (3) excess heat is supplied to the feed (that is, part of the bottoms is vaporized), rigorous control of the charge rate and of the outlet temperature of the furnace is usually not essential. If, however, no excess vaporization occurs, or if manual draw-off control is used, then both the charge rate and the outlet temperature must be well controlled. In any case, provision for maintaining a relatively constant charge rate is desirable.

A system of furnace control which is particularly successful when the amount of vaporization in the still is sensitive to changes in the outlet temperature, uses the inlet pressure of the still as an index of the outlet temperature. As the temperature increases and more vaporization occurs, the charging pressure increases, and the variation of this pressure is used to actuate a valve in the fuel oil line.

An interesting furnace control is discussed by Poole.[16] The temperature of the furnace cavity is the normal actuating variable, but this control point is automatically superseded in emergencies by control based on the oil temperature. Recently one of the instrument companies has perfected a system of furnace control in which the fuel fired is regulated by a control actuated primarily by the temperature of the furnace cavity and secondarily by the oil temperature in the radiant tubes. With this two-point system of control, hunting is largely eliminated. Both of these controls use auxiliary flow-meter regulators for the maintenance of a constant charge rate, both are essentially trend-analyzing instruments and both provide compensation for the time lag.

Operation

Operators have long been accustomed to judge the operation of a fractionation unit by noting the gravity of a sidestream product. Unfortunately, the gravity of a product is not a reliable criterion of fractionating efficiency. As an example of how the boiling range of a product may vary while the gravity remains constant, Figure 1 presents

three well-fractionated kerosene products produced from the same crude oil in a commercial fractionating unit under different conditions of operation.

If sufficient heat is supplied to more than vaporize a side-draw product and if the top temperature remains constant, withdrawing a larger quantity of product from the side of the tower increases the width of a cut, so that the endpoint, gravity or viscosity of the product increases. The converse is also true. However, if only enough heat is supplied to vaporize the side-draw product, then the withdrawal of a large quantity of side product will result in a wider cut, but the boiling range, gravity and viscosity will decrease. Consider a 15-plate rectifying section of a column producing only kerosene as a side product. Except for differences in the degree of fractionation, a commercial kerosene product may be withdrawn from any of the plates between the third and the twelfth. After a sufficient length of time for the conditions in the column to reach a new equilibrium, any one of the plates used for the withdrawal of kerosene will come to the normal kerosene draw-plate temperature and the material on the plate will have the composition of the desired kerosene product.

The degree of fractionation is often gauged by the "gap" or "overlap" between the A. S. T. M. endpoint of one product and the initial boiling point of another. Normally this temperature difference is an indication of the success of the separation between products, but in processing certain freak stocks the gap cannot be relied upon as an indication of the fractionation. As an example, in processing a bright stock-naphtha solution a gap of 130 degrees F. was produced between the endpoint of the naphtha product and the initial boiling point of the gas oil product, although the two materials were very poorly fractionated. This freak charging stock contained about only 1 per cent of gas oil, hence the misleading gap of 130 degrees.

Centralized Control

The central control room has become an integral part of the modern petroleum distillation unit. The grouping of recording and controlling instruments facilitates the work of the operator and concentrates the responsibility for the operation of the plant. Although the first cost of centralized and automatic control is high, it reduces the number of operators required to man the plant and provides an appreciable saving in operating cost. When dealing with emergency shutdowns, such as those arising from explosions and fires, the facility afforded by centralized control is of vital importance.

On the other hand, enthusiasm for the very real advantages of centralized control should not be allowed to obscure its limitations. Control instruments are expensive and the lines between the control room and the equipment are costly. For this reason the less important measurements should be taken at the equipment, and indicating instruments should be given preference over recording instruments except where a record of the operating conditions is of definite service. Since a large number of instruments in the control room divides the attention of the operator, careful thought should be given to the selection of the data which is to be presented for the attention of the control room operator.

Automatic control has been tried and proved under a variety of operating conditions. It is now accepted as a necessary part of the equipment of a modern plant. Automatic control is a valuable tool to the petroleum engineer, but, like any other tool, it should not be applied to a task for which it is unnecessary or unsuited.

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Continental Oil Co. Has New Refining Unit

THE atmospheric pressed distillate rerun unit recently placed in operation by Continental Oil Company at its Ponca City refinery was another step forward in maintaining refinery equipment at modern engineering design. Modernized refinery equipment to obtain utmost economy in operation, and maximum yields of a high quality product in each commodity produced is the big, vital problem confronting the manufacturing department of every company today.

The contract for the purchase and erection of this 3,000 barrel per day unit was let to the Alco Products Company, subsidiary of the American Locomotive Company. The unit was primarily designed for rerunning pressed distillate, but in addition adequate capacity was allowed for processing 3,000 barrels daily of cylinder stock solution.

Pressed Distillate Rerun Operation

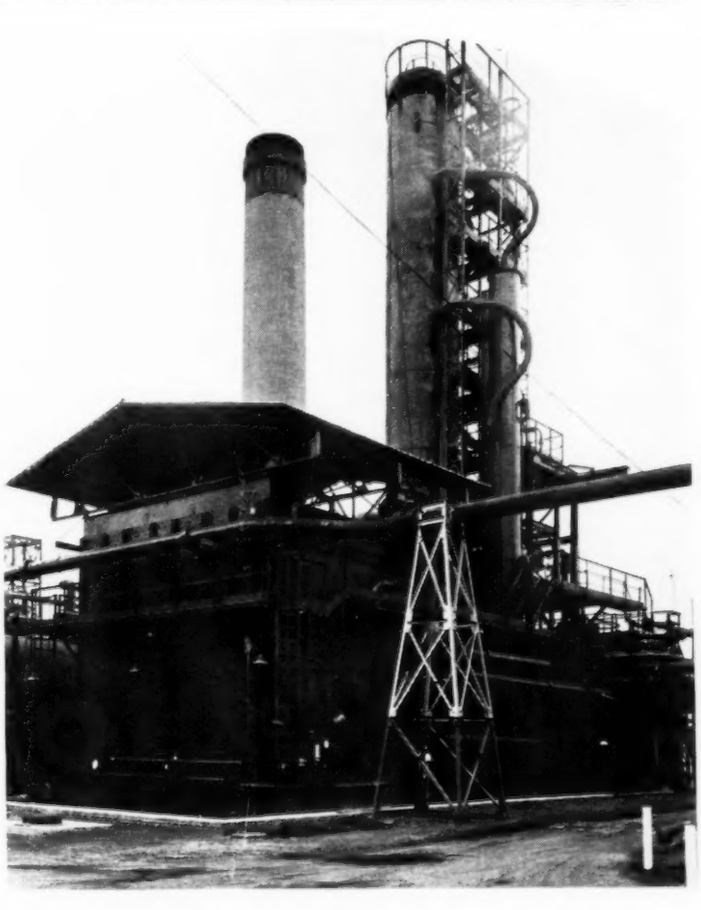
The pressed distillate charging stock to the rerun unit is obtained by carefully chilling and removing the wax from a wax distillate overhead cut taken from selected crude stocks. After the removal of the wax the pressed distillate having a zero cold test is within the gravity range of 29-30 degrees A. P. I. and has a viscosity of 70-75 seconds Saybolt Universal at 100 degrees F. The distillation range of this stock is from 200 degrees F. initial to 560 degrees F. end point as determined on a U. S. Bureau of Mines apparatus run at 5 m.m. absolute pressure.

All guaranteed yields of neutral stocks from the rerun unit were based on the yield as determined by the laboratory on a 4,000 c.c. charge run on a Smith and Leslie true boiling point column packed with rings and operated at 2.5 m.m. absolute pressure.

The pressed distillate charge to the furnace is automatically controlled by a recording flow controller in the discharge line from the centrifugal charging pump. The charge is preheated by exchange with the overhead gas-oil stream and the main tower bottom stream to 370 degrees F. before entering the furnace at 35 to 40 pounds gauge pressure. The oil leaves the furnace around 710 degrees F. and five pounds gauge pressure under which conditions the oil is about 55 per cent vaporized. The tower operates at atmospheric pressure at the top with about one and one-half pounds gauge pressure at the bottom.

When processing the above range of pressed distillate the bottoms are run for viscosities of 180-280 S.S.U. at 100 degrees F. as desired, and give a finished treated neutral oil having a high flash point as determined by the A. S. T. M. Cleveland Open Cup; this flash point for 220 S.S.U. at 100 degrees F. is not less than 405 degrees F. The actual yields of 240 viscosity stock was 102 per cent of laboratory yields as determined from the Smith & Leslie true boiling point packed column operated at 2.5 m.m. absolute pressure.

The tower is designed to draw two neutral stock side stream cuts. The first or upper stream having a viscosity of 70-100 S.S.U. at 100 degrees F., the flash of the 70 viscosity stock being not less than 340 degrees F. and the flash of the 100 stock not less than 360 degrees F.; both as determined by the A. S. T. M. Cleveland Open Cup test. The actual yield of 70 viscosity stock was 100.7 per cent of laboratory yield as determined by the Smith and Leslie vacuum column.

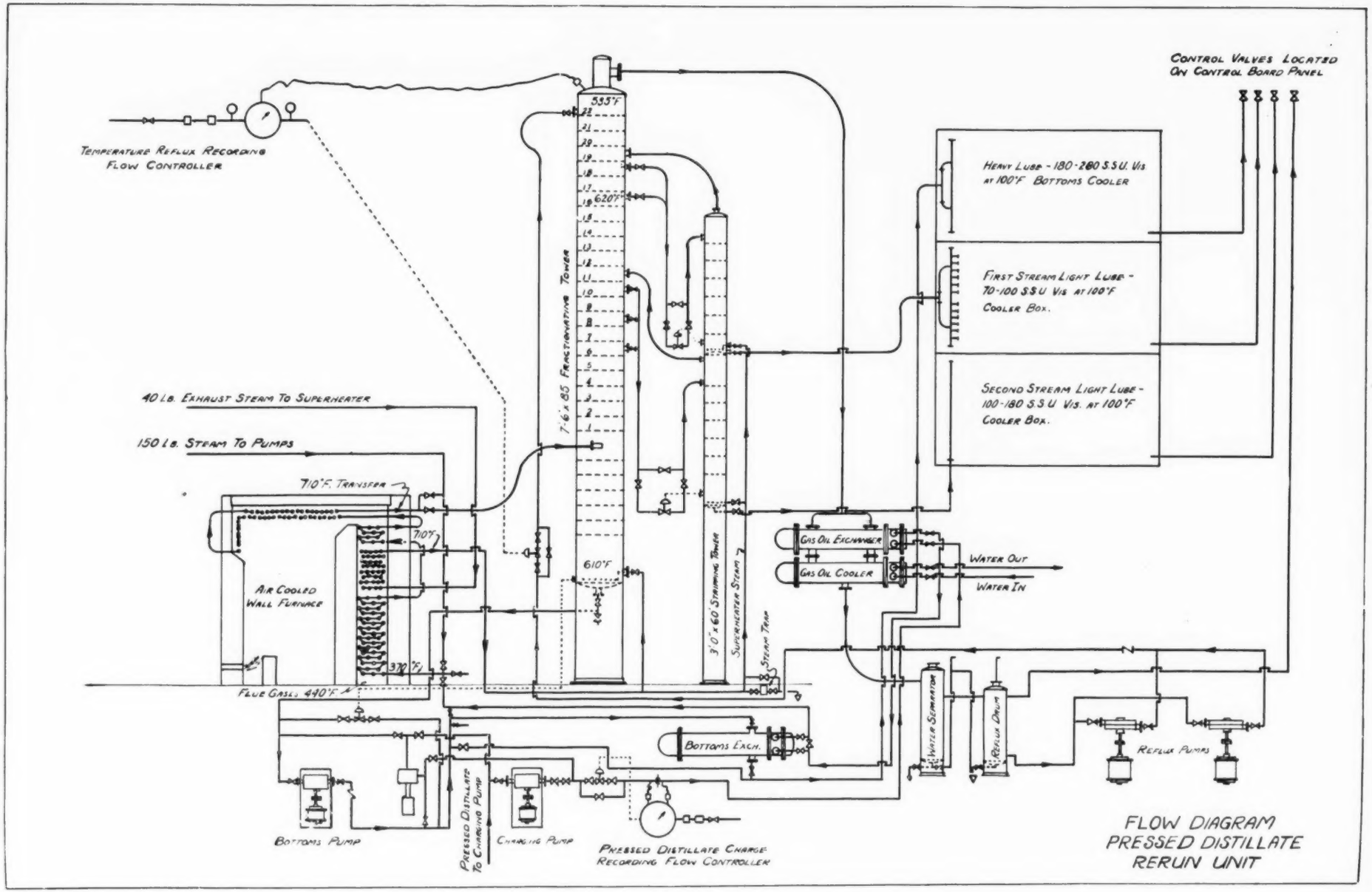


Alco unit just after completion at the Ponca City plant.

The lower or second neutral stock side stream cut has a viscosity of 100-180 S.S.U. at 100 degrees F., the flash of which was not less than 360 degrees F. for the 100 viscosity stock, and not less than 395 degrees F. for the 180 viscosity stock; both flashes as determined by the A.S. T.M. Cleveland Open Cup test.

The fractionation of the overhead gas-oil cut is close enough so that the distillation of the end point of the gas-oil will not exceed the temperature of the 10 per cent point of the first side stream cut of neutral stock; both distillations being run at 5 m.m. absolute pressure on the U. S. Bureau of Mines apparatus. The heat content of this gas-oil stream is utilized in preheating the pressed distillate charged to the furnace.

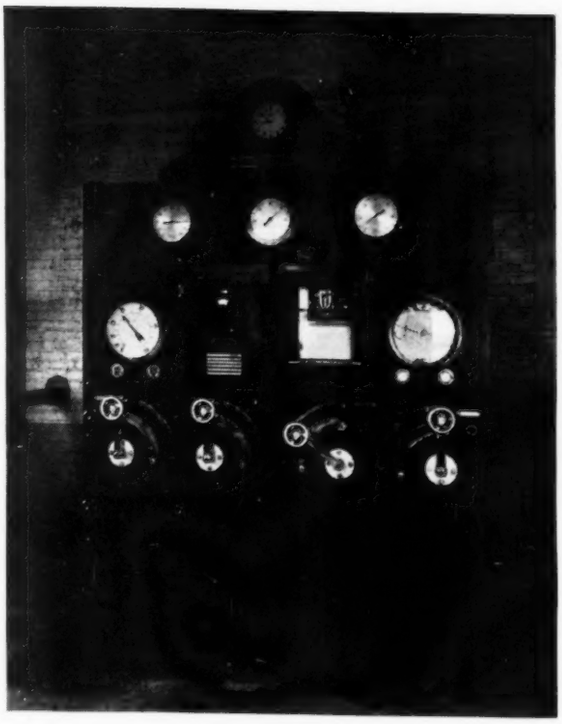
In addition to improving quality and yield of products any modern


CONTROL VALVES LOCATED ON CONTROL BOARD PANEL
TEMPERATURE REFLUX RECORDING FLOW CONTROLLER
595°F
620°F
610°F
7'6" x 85 FRACTIONATING TOWER
3'0" x 60' STRIPPING TOWER
SUPERHEATER STEAM
STEAM TRAP
HEAVY LUBE - 180-280 S.S.U. VIS AT 100°F BOTTOMS COOLER
FIRST STREAM LIGHT LUBE - 70-100 S.S.U VIS AT 100°F COOLER BOX.
SECOND STREAM LIGHT LUBE - 100-180 S.S.U VIS. AT 100°F COOLER BOX.
40 LB. EXHAUST STEAM TO SUPERHEATER
150 LB. STEAM TO PUMPS
710°F. TRANSFER
710°F
AIR COOLED WALL FURNACE
370°F
FLUE GASES 440°F
GAS OIL EXCHANGER
GAS OIL COOLER
WATER OUT
WATER IN
BOTTOMS EXCH.
WATER SEPARATOR
REFLUX DRUM
REFLUX PUMPS
BOTTOMS PUMP
PRESSED DISTILLATE TO CHARGING PUMP
CHARGING PUMP
PRESSED DISTILLATE CHARGE RECORDING FLOW CONTROLLER
FLOW DIAGRAM
PRESSED DISTILLATE
RERUN UNIT

unit must be closely designed to show low fuel consumption with high economy, low steam and power consumption, and show a material saving in chemicals needed to treat the products obtained. The mechanical construction must be simple and rugged to give a low future maintenance expense.

The acid requirement for treating the bottoms from this unit was reduced one-half compared with the acid requirement for treating the bottoms from shell still operation. The resulting color being equal to or better than obtained from reducing the shell still bottoms stock.

Proper control of transfer temperature and quantity of 40-pound superheated steam used in the fractionating tower and strippers permit easy control of the desired products.



Instrument board on the Alco unit.

Mechanical Features

The furnace is constructed to allow about 75 per cent of the total furnace duty of 12,000,000 B.T.U. per hour to be picked up in the radiant side wall and roof tubes. The large per cent of the latent heat of vaporization being supplied in the protected zone of the upper row of roof tubes. The convection or preheater section of the furnace is designed to give high gas velocities and a high convection heat pick up. This is borne out by the temperature of the exit flue gases from the furnace being 440 degrees F. and approaching within 70 degrees F. of the temperature of the incoming charge of pressed distillate which has been heated by exchange to 370 degrees F.

These flue gases over the bridge wall have a temperature of 1,200 degrees F. with a furnace draft over the bridge wall of 0.01 inch of water. However, the pressure drop through the convection section of the furnace and flue breeching is considerably lower than might be expected as the stack draft is only 0.41 inches of water.

The analysis of the flue gases over the bridge wall shows 11.6 per cent CO_2 with only 9.6 per cent excess air, while the analysis of the gases at the breeching shows 9.8 per cent CO_2 and 28.4 per cent excess air. Neither analysis shows any trace of CO. The over-all combined oil and superheater efficiency of the furnace shows 75 per cent based on the low heating value of fuel.

The brick work of the entire furnace, including the bridge wall, is of air cooled construction. The outside covering of one-half inch transite board over the steel work when painted gives a lasting and very neat finished appearance.

There is considerable discussion as to the relative merits and economy of an air cooled wall tube still furnace, compared to the conventional 18-inch or 22-inch solid wall furnaces. The sealed passages on the air cooled wall furnace will give a slightly higher radiation and conduction heat loss, but it is felt that this loss will be more than balanced by lower maintenance cost on the brick work and a lower leakage of air into the furnace from cracks developing after a certain length of operation of the furnace. The development of cracks and consequent increase of air content, as shown in the exit flue gases, costs a great deal in the economy of furnace operation and the rate of heat pick-up through the convection or preheater section of the furnace.

A unit of this type lends itself very nicely to experimental work and theoretical calculation checks, since there is definitely no cracking taking place and consequently each tube or section of the furnace may have its heat pick up duty and pressure drop calculated and actually tested. Such a series of tests were carried out on this furnace by embedding in several headers throughout the furnace thermo-couples and tapping for pressure gauge connections. A series of temperature and pressures were taken under normal operation. Likewise complete temperatures, drafts and flue gas analysis were taken for a heat balance check.

The following series of curves was then plotted:

1. A temperature rise curve, plotting observed temperatures as ordinate and linear feet of oil tube with allowance for return bends as abscissa.

2. A pressure drop curve, plotting gauge pressure as ordinate and linear feet of oil tube with allowance for return bends as abscissa.

3. A series of points were calculated for pressure drop in pounds per square inch per 100 feet of length and plotted as ordinate and tube length again as abscissa. These pressure drops were calculated from Waker, Lewis and McAdams formula and data with due allowance for viscosity and gravity changes with temperature.

The first two curves permit checking of pressure drop calculations and data on thermal properties of the oil as well as radiant and convection heat data.

The third curve of calculated pressure drops shows a constant pressure drop for about 1,200 linear feet of tubing, and then a gradual drop for a considerable distance as the increased temperature decreases the viscosity and gravity of the oil. This curve suddenly begins to rise as vaporization begins in the lower row of roof tubes, and after a short distance begins to rise very steeply. By graphical integration of the area under this curve it is possible to estimate the per cent vaporization of the oil in each section of the furnace tubes. The total vaporization thus calculated checked very closely the heat as shown by the heat balance around the tower.

Cold Weather Pointers for Ditcher Maintenance

PARADOXICAL as it may seem, the shortening of operating time of a ditching machine during freezing weather will permit the operator to cut more trench per day, over a period of time. When a machine is being operated during daylight hours in a territory where the days are comparatively warm and the nights freezing, many operators order their ditchers shut down 30 minutes ahead of schedule. This is done to give the operator time to make necessary provisions to prepare the machine for the night's freeze and have it so it will start with the least delay the following morning.

For such conditions G. C. Swartz, then Superintendent, Maintenance, Williams Bros., Inc., and now district manager, Buckeye Traction Ditcher Co., worked out a method of machine operation that saved both repair bills and delays. That method started with a careful check of the daily weather reports for the territory in which machines may be operating. If freezing weather was predicted that information was forwarded to each machine operator by division men.

Should the machine be working in mud or wet country with a freeze expected the operator is required to shut down 30 minutes ahead of schedule. Skids are thrown on the ground 10 or 15 feet ahead of the last ditch to be cut and the machine's crawlers stopped on the skids.

Upon starting the following morning each block on the crawler easily breaks away from the skid and eliminates the necessity of "rocking" the machine back and forth as would be the case should it be frozen to the ground. The latter evil is attributed to be the cause of many shaft failures although they may not occur at the time. When the temperature drops to freezing or below, the metal is more likely to fracture. As the machine is "rocked" violently at such times there is danger of imposing sudden stresses that are liable to set up fractures in the metal. This may not be noticed at the time but the damage has been done and the material will eventually fail, possibly under normal conditions.

When a freeze is likely the digging wheel or ladder should be raised out of the ditch. Expansion of water in the sidewalls will bulge them outward during a cold spell which will freeze the buckets and require an unnecessary stress on the machine to free them.

Particular care should be exercised in removing mud from between the saber tooth bucket cleaners and fingers on the buckets. Should the mud freeze in such places it will probably result in the curved fingers on the bucket being straightened out when they reach the saber tooth cleaners.

Mud should also be removed from the sprockets and the truck wheels on the digging wheel. If the truck wheels are permitted to freeze they will wear flat quickly and require replacement. After the mud is removed the parts should be lubricated. Under no conditions should a motor be thawed with a torch. It is perhaps assumed that because the machine is of steel construction the fire hazard is virtually nil. Yet, each year thousands of dollars are represented in the repair toll due to fires. Only recently a $7,500 machine in the Mid-Continent caught fire and before the oil fire on the machine could be checked about $3,500 damage was done.

It is easy for water to get in the gasoline cans used in the field and for this reason contractors require operators to close the valve on the fuel line at the tank and drain the carburetor. If it is necessary to thaw the machine the parts to be heated should be wrapped with rags and hot water poured on them. Usually a crew will build a fire each cold morning at a point a safe distance away from the machine and a bucket of water could be heated over it.

By exercising care and devoting a short period daily to cleaning the machines more ditch per day over a period of time is cut because costly delays are minimized. The same methods of maintenance may be used with equal success on backfillers.

Christmas
Greetings

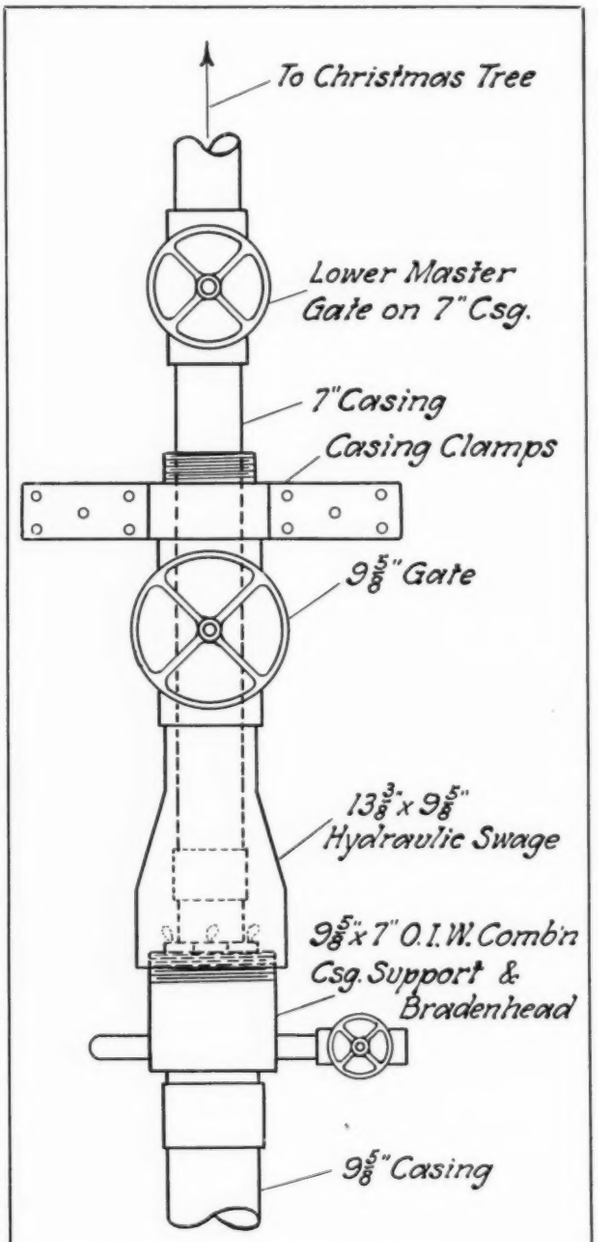
Engineers Design New Type Cellar Hook-Up *for* Unruly Wells

A NEW type cellar hook-up, particularly suitable for controlling high-pressure oil wells that produce sand, has been designed by engineers of the Indian Territory Illuminating Oil Company and is now installed on several of the company's wells in the city limits area of the Oklahoma City pool. The new flow connection is especially desirable for installation on wells in the Oklahoma City field, where flow connections are always subject to considerable cutting because of sand produced with the oil, and "wild" wells may easily result. These wells must be quickly controlled to avoid being confronted with a gigantic fire hazard and prevent serious damage to adjacent homes and properties.

With the new type flow hook-up it is not intended to reduce sand-cutting any more than can be done with connections now used, but instead it offers a quick, easy means of shutting a well in if it commences to leak around some of the gate valves or flow lines. A 9⅝ by 7-inch, 8-thread, Oklahoma Iron Works combination casing support and bradenhead is placed in the extreme lower part of the cellar, beneath the regular master gate valve. A 13⅜ by 9⅝-inch hydraulic swage is attached to the upper part of the combination head; the smaller diameter end of the swage, which is on the top end, is coupled to a short joint of 9⅝-inch casing, on which is installed a 9⅝-inch gate valve.

The 7-inch flow string of casing runs through the interior of this hook-up and projects upward to the regular Christmas tree connections, with the lower master gate valve on the 7-inch casing placed immediately above the 9⅝-inch gate valve. Since the entire flow of oil is through the 7-inch casing, the 9⅝-inch gate valve, hydraulic swage and short joint of 9⅝-inch casing are never in contact with the flow of oil, consequently are not subjected to any wear or cutting, and as a result are always in good condition.

On the 7-inch casing at a point within the swage is a nipple which permits the 7-inch string of pipe to be backed off at this point. If a well becomes wild because of the upper connections having become sand-cut, it is only necessary for workmen to back the 7-inch casing out of the nipple and remove it with the regular Christmas tree, all of which becomes free after unscrewing the 7-inch from the nipple. When this operation has been performed the 9⅝-inch gate valve is left free and can be closed, shutting in the well.



SKETCH SHOWING SWAGE ON CASING SUPPORT

The company is placing this type connection on many of its wells in the field. Although this hook-up has not yet been called upon in an emergency, it is believed by its use to be able to shut in a "wild" well within a short period of time.

Another plan of this company to eliminate as much danger from "wild" wells as possible is to make a detailed sketch of all well connections. These drawings have now been made for many of the wells in the Oklahoma City pool and are being completed as rapidly as company engineers can take dimensions at the well and make the drawings.

The company once experienced difficulty in subduing an unruly, wild flowing well because they did not know the number of threads in a cellar casing connection, hence the adoption of the above plan. The drawings being made show the number of threads, all gate valves, distance between gate valves, direction of stems, distance from derrick floor, and other useful information.

In case of a "wild" well, the drawings would show just where the connections might be removed and the exact length and number of threads needed to install new connections, meaning the saving of much time and possibly a serious error in making up new connections. The sketches are kept in a file so they will be easily accessible. In time the company will have a detailed drawing on file of all its well cellar connections and Christmas trees in the Oklahoma City field.

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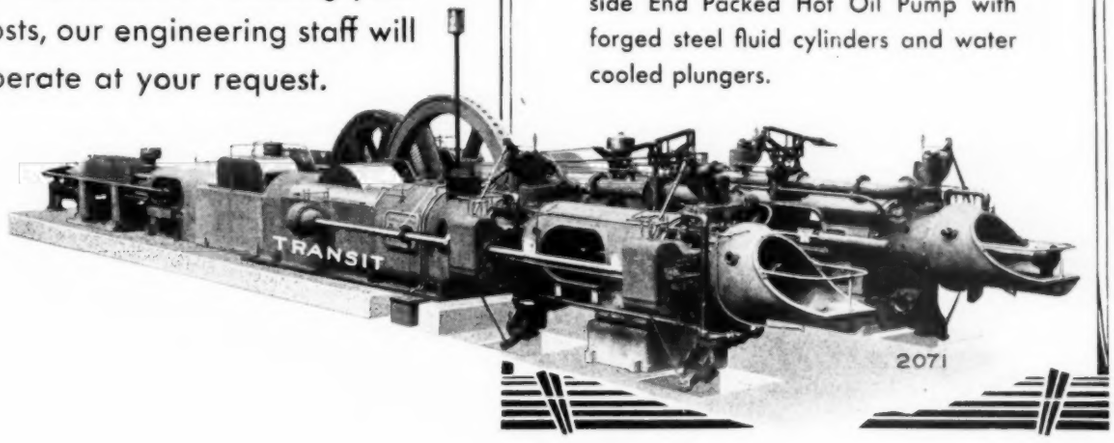

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FIELD PUMPS
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Van Proration Based on Acre-Feet of Formation Thickness

By J. C. GORDON, *Petroleum Engineer, Fort Worth, Texas*

THE Van field in Van Zandt County, Texas, has had restricted production since the discovery of the field in the latter part of 1929. Since discovery, over 20,000,000 barrels of oil have been produced. A total of 261 wells have been completed in the field; five of these are gas wells. Sixteen of the completed oil wells are pumping, and are located on the edge of the field. The remaining oil wells are flowing through 2½-inch tubing and chokes. The five gas wells are shut in to conserve gas. The average bottom-hole pressure is now 1,200 pounds, a decline of about 100 pounds in the two years of operation.

All wells when completed as producers are tested for three hours through a choke of ¼-inch diameter. The amount of fluid produced the second and third hours is averaged and recorded as the hourly potential of the well. Needless to say the daily potential figures based on the tests through tubing and small chokes are very conservative.

The daily production from the field has gradually been increased to 50,000 barrels, withdrawals from the reservoir have been regular, with a low gas-oil ratio.

The productive area of the field was divided into units of twenty acres each. The potential production of the field and of each unit was determined from the potential tests. The daily allowable for each unit was determined by multiplying the daily average potential of each unit by the relation between the total daily average potential of the units and the allowed daily production from the field. Adjustments were made to keep the production from offsetting wells uniform, and each well was allowed a minimum of 100 barrels per day. The allowable for each lease was that of the units or sections of units comprising the lease.

On March 20th, 1931, this proration plan was changed slightly by increasing the size of the units from twenty acres to forty acres each. This change was made to reduce the number of wells which would have to be drilled to prove the smaller units.

On October 15th, 1931, a new order was issued by the Texas Railroad Commission, changing the proration plan entirely. This new order put into effect a method of prorating production which was planned and worked out by the production engineers of the Pure Oil Co., which company is operating the unit area owned jointly by the Pure, Shell, Texas, Sun and Humble companies, and is operating leases which cover about half the producing area not covered by the unit operation. The other companies operating in the field and the Railroad Commission approved the plan which is quite a departure from the methods of prorating in other areas.

The new order provides that the daily production of the field be limited to 50,000 barrels of oil per day. This production is prorated among the leases according to the number of productive acre-feet of Woodbine formation.

To obtain the productive acre-feet of each lease, a contour map was prepared, showing the contour lines of equal Woodbine formation thickness above a subsea datum line of 2,500 feet, which is the water level. The contour lines, at 50-foot intervals, were based on the records of the 261 wells drilled in the field. By planimeter measurement of the leases on the contour map the number of productive acres in each lease was obtained. The average Woodbine formation thickness of each lease was also obtained by planimeter measurement of the contour map. Multiplication of the total productive acres of each lease, by the average Woodbine formation thickness, gave the total productive acre-feet. Each lease's share of the total production from the field is the relation that the acre-feet of that lease bears to the total acre-feet of the field.

Small adjustments are made in some cases in order that each well may make a minimum allowable of 25 barrels of oil per day, and in case of the inability of the well or lease to make the allowable which has been allotted.

Months were required to complete the contour map and to work out the method of proration. Less than half the wells in the field have been cored. With the wide range of sand identification possible from cores, the method of contouring total sand encountered in the formation was discarded. Porosity tests of sections of all the cores are now being made by the Pure Oil Co. in their laboratory at Van, but this work will not be completed for some time. Practically all wells in the field were completed at a subsea level of 2,450 feet, leaving 50 feet of unpenetrated formation which is included in the total Woodbine formation considered as productive. On account of the incomplete core records, porosity and degree of saturation of the sand was not used as basis for the contour map. A study of the bottom-hole pressures was not made but in all probability the contours based on pressures would have followed closely the contours based on total Woodbine formation thickness. At Van, with the fairly uniform sand condition, contours based on the total thickness of the producing formation leave little room for error and difference of interpretation.

The new order allows for a variation of 10 per cent from allowables set by the above methods for leases in the area controlled by the Unit, approximately 80 per cent of the entire field, but the total allowable from the Unit is not to be altered. This allowed variation permits some corrections for variations in bottom-hole pressures, etc.

The total productive acre-feet in the field is calculated as 1,171,410 under a surface area of 4,159 acres of oil producing territory. The average formation thickness for the entire field is 281.6 feet, while the maximum thickness shown by the contour map is 650 feet.

Although the Van field covers a small area when compared to the enormous field of East Texas, Van contains at least one-third as many total acre-feet of Woodbine producing formation as the entire East Texas field as now outlined.

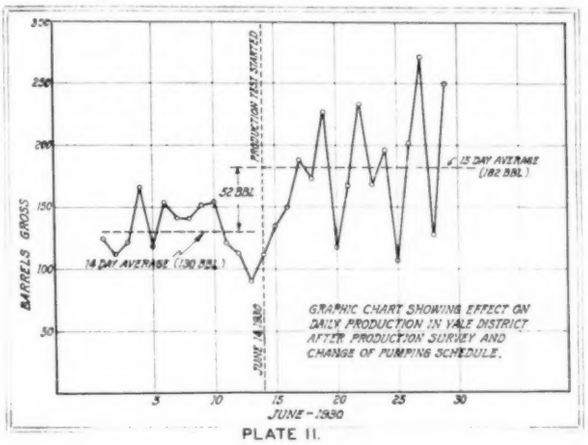
The use of acre-feet of producing formation as a basis for production allotments, controls withdrawals from the reservoir in a systematic manner, eliminates unnecessary wells, eliminates the advantage frequently held by owners of small tracts over owners of large offsetting leases, and seems to be a fair method for all concerned, and for these reasons is a decided advance in proration method. Unit operation of the greater portion of the Van field made possible the application of this proration method.

Using Data from Individual Wells to Set Up

Lease Potential and Production Ratio

By FRANK B. NEPTUNE, *Petroleum Engineer, Bartlesville, Okla.*

IN the first article of this series, which appeared last month, some of the advantages of keeping a record of the oil and water production of the individual stripper well were pointed out with reference to repair work, additional drilling, etc. Another advantage, in terms of increased producing efficiency, is entirely possible by carrying the process a bit further. If the operator goes to the expense of providing for periodical tests of the production of his small wells, he certainly should use the information thus obtained to the fullest extent, not only to guide him in making decisions relative to repair work, etc., but in getting the maximum production from every well he is operating. There are times when the less oil the operator has to pump from the ground the less he loses; but such occasions are, fortunately, uncommon. Ordinarily a barrel of oil represents a unit of profit and the operator is desirous of realizing the maximum recovery daily, since the operating costs do not vary greatly whether the property produces ten barrels or a hundred barrels. Even when the price of oil is high, the old lease with its stripper wells often is badly neglected. There is usually a flush area that is occupying the time of the general superintendency and the technical staff and the old properties are left in the hands of the field men who actually operate them.


BARRELS GROSS
PRODUCTION TEST STARTED
15 DAY AVERAGE (182 BBL.)
52 BBL.
14 DAY AVERAGE (130 BBL.)
GRAPHIC CHART SHOWING EFFECT ON DAILY PRODUCTION IN YALE DISTRICT AFTER PRODUCTION SURVEY AND CHANGE OF PUMPING SCHEDULE.
JUNE 1, 1930
JUNE - 1930
PLATE II.

A few years ago an independent operator in the Mid-Continent field was operating a number of small leases and among them was a small property which had produced an average of fifteen barrels daily for about three years. The operator kept a production-decline curve for each of his leases, but did not make tests of the production of the individual wells. The decline curve of the property in question showed it to be declining very slowly and the owner decided to do some needed repairing and cleaning out. Preparatory to starting the work, he sent an engineer from the office to make a production test of each well. The first well tested produced thirty-three barrels the first day and eighteen barrels on the two following days. As the well while being tested was pumped the same number of hours as it was pumped in the ordinary course of its operation, and as this one well was found to produce more oil alone than the entire property of nine wells had been producing for several years, an investigation was made. It was found that this well was pumping into a line which also gathered oil from three other wells. Of the three other wells on the line, two were being pumped but once each week and the third had been standing idle for some time. Further investigation showed that the two wells which were pumped once a week were pumping up only such oil as was leaking back into their tubing through a faulty check valve and that the idle well was also receiving part of the pumped production of the eighteen-barrel well by reason of a leaky check valve and either leaky tubing, leaking standing valve, or both. In other words, all the oil from the eighteen-barrel well, with the exception of about four barrels, was being pumped back down three other wells, where part of the oil was being pumped back by the two occasional pumpers and credited to them. As nearly as could be determined, this condition had existed for at least eighteen months and an average of ten barrels a day had been lost during this time. This, of course, is an extreme case, but a system of periodic individual production tests would have prevented this loss. The following is a suggested plan for taking up some of the loose ends in production practice and keeping the operator more closely in touch with the stripper well. Of course, a condition is presupposed where the price of oil makes it worth while, and that condition exists whenever the price is such that a barrel of oil can be produced at a profit. The plan is built around the establishment of a "potential" for each old property, based upon the total of the production of the individual wells as shown by the last test. For example, suppose the June test for a certain property having ten wells showed the following as the actual production by wells when tested by one of the methods reviewed in the earlier article of this series:

Well No. 1.....	5 bbls. oil	3 bbls. water	Pumped 3 hrs.
Well No. 2.....	10 bbls. oil	8 bbls. water	Pumped 7 hrs.
Well No. 3.....	2 bbls. oil	5 bbls. water	Pumped 1 hr.
Well No. 4.....	7 bbls. oil	0 bbls. water	Pumped 3 hrs.
Well No. 5.....	15 bbls. oil	0 bbls. water	Pumped 12 hrs.
Well No. 6.....	12 bbls. oil	1 bbl. water	Pumped 8 hrs.
Well No. 7.....	6 bbls. oil	2 bbls. water	Pumped 4 hrs.
Well No. 8.....	3 bbls. oil	0 bbls. water	Pumped 2 hrs.
Well No. 9.....	3 bbls. oil	0 bbls. water	Pumped 2 hrs.
Well No. 10.....	2 bbls. oil	2 bbls. water	Pumped 3 hrs.
Total	65 bbls. oil	21 bbls. water	

The 65 barrels of oil represents what the lease will produce daily if every well is pumped as it was when tested and no wells are "off." This assumes that the wells were tested carefully enough so that the figures shown represent very closely the actual everyday producing capacity of each well. The "potential," then, of the property would be set down as 65 barrels and would remain there until a subsequent test changed it. Suppose, then, that for the same period the property actually averaged 50 barrels daily, the "production ratio" or "producing efficiency" would be set. Using the above nomenclature, the production ratio would be 50/65, or 0.768, and the producing efficiency would be about 77 per cent.

It is improbable that a property will produce over a given time the amount of oil that the sum of the individual well tests indicate as being possible. In the first place, while a well is on test it is pumped off more carefully than when it is being pumped in the ordinary course of operation. Further, the well may, at the time it is tested, be actually in better producing condition than usual. Wells which are inclined to give trouble are generally pulled and recupped just before starting the production test, and as a result show up somewhat better than their true average. On the other hand, the wells may be pumped carelessly and only partially pumped off at the time of the test—or some wells may be "off" for one reason or another and the resulting "potential" may be too low to be truly indicative of the lease capacity. In such cases, if the subsequent operation is free from trouble, the actual recovery for the period may be higher than the "potential" and the producing efficiency will be over 100 per cent.

There are a lot of practical considerations. In the first place, few pumpers would be interested in obtaining a high "potential" on the test if they know they will be expected to pump about that much oil from their wells every day. They would see to it that their total of the individual wells was just about what they had been pumping in the past. They would try to set the potential at a point they could reach without straining. If the testing of the wells is left to the men operating the property, you may be sure they will not set the potential too high. This is only natural and is in no way a reflection upon the lease men. It has been the writer's experience that the great majority of pumpers are interested in the wells they operate and make an earnest effort to hold up the production to the highest possible point; but many times they are greatly handicapped by lack of co-operation from superiors and these superiors may in turn be handicapped by lack of equipment. The system here set out is not designed to check up on the pumper or lease foreman, but upon the whole system. However, to insure tests being made fairly, the actual well testing should be done by a disinterested party—a sort of "traveling pumper" whose only interest is to determine what each well on the lease will produce when properly pumped. This does not mean that the so-called "traveling pumper" would go on a lease and endeavor to pump every drop of fluid from the wells—he would necessarily have to consider the condition of the wells. Some wells will not stand up under hard pumping because of sand conditions. Some wells must have a high fluid level to operate at all. The "traveling pumper" would be familiar with the wells he tested and would pump them according to the dictates of experience. His salary and expense would be allocated to the various properties according to the time he spent on each—or according to the amount of production on each. This latter method would place more of the charges on the properties best able to bear it. Increased production efficiency, based upon actual increased production, should more than offset the expense of one man in a district.

The results of the well tests, showing oil production, water production and pumping time for each well, should be sent to the office of the general superintendent, who would check the total or "potential" of each lease against the actual reported production by periods. A suggested form for use of the general superintendent's office is shown on Figure 10. This form would be posted weekly as to actual production of the various leases from information supplied by the oil accounting department. Weekly postings allow the superintendent to spot a questionable condition before it has existed very long. In the posted columns on the suggested form the actual production for the past week is entered. This may be a total week's production, or it might be the daily average for the week—the only important matter being to have the "potential" and the actual in like terms. Right below the actual production is a column for the "potential" production as indicated by the last test. The third column is the ratio of the actual to the "potential" and is the indication of the producing efficiency. Right after the postings are made and the production ratio figured, the superintendent can tell by glancing down the columns and noting the ratios, which leases are falling down in production. Of course, he could tell this without a production ratio, but he would not know whether or not the drop represented a natural decline. If a lease shows a potential of 100 barrels on test month after month, yet actually produces only 50 barrels each month, he would probably be interested in finding out what is wrong. On the other hand, if he had no idea what the lease is capable of pumping and the production is reported at 50 barrels month after month, he probably will assume that the lease is doing its share. If the ratio is low, it indicates underproduction. This underproduction might be due to causes beyond the control of the lease men and it might not, but the figures indicate the relation between what the lease *is* producing and what it *can* produce. It should serve as an indicator of production lost for any reason whatsoever.

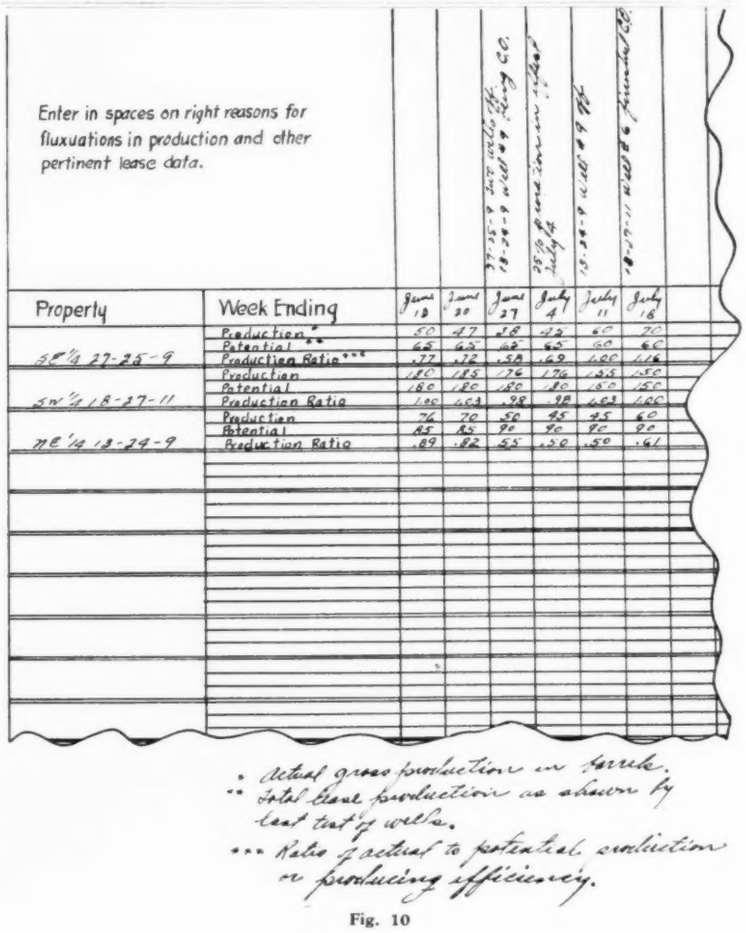


Fig. 10

Seasons Greetings
FRICK-REID

Oklahoma City Offers Interesting Pumping Problems

WHEN the Oklahoma City field arrives at the pumping stage of its life it will probably be the most interesting experimental pumping area in the country. Many new pumping devices will be tried out and much equipment material improved upon from the experience gained in the severe service that will be demanded in this field. Interest in the successful pumping possibilities of the 6,500-foot wells has been materially increased recently as several operators are doing preliminary work toward placing wells in the central and southern portions of the field on the pump. This is recognized as indicating that these operators are of the opinion the pumping stage will shortly be reached and that the wells can be pumped successfully.

In the meantime company engineers are carefully studying all phases of pumping difficulties likely to be encountered as a result of the great depth and heavy loads. Already a number of wells have had prime movers and other rig pumping equipment installed and next year an increase in pumping installations will doubtlessly be witnessed. Many wells, particularly those in the Wilcox sand area, will not reach the pumping stage for some time, but a number of wells in other parts of the field are showing actual signs of soon reaching the point where pumping will be necessary.

Attention is now focused on two wells that have the rods and pumps installed in the hole and working. Of these, the Continental Oil Company's No. 5 Vincent Sudik, in the extreme southern part of the pool, is the more interesting because it depends solely upon pumping operations to make its production, while the other well, a nearby location belonging to Indian Territory Illuminating Oil Company, is making its production largely by agitation rather than by pumping.

The Vincent Sudik well is given a potential output rating of 450 barrels per day, which entitles it to a production of 75 barrels every 10 days. Since March of this year it has been making its production by pumping about seven hours every tenth day. The last time it was pumped the well produced 71 barrels during its seven-hour production period. It is extremely interesting that the well has never been touched since the rods were installed, but of course its actual pumping time has been rather limited. The only time it was not pumped every tenth day was during August and September, when martial law shutdown prohibited any production. The result from this well's pumping record are considered encouraging, although it has actually pumped but six full days, and 18 days of seven hours each.

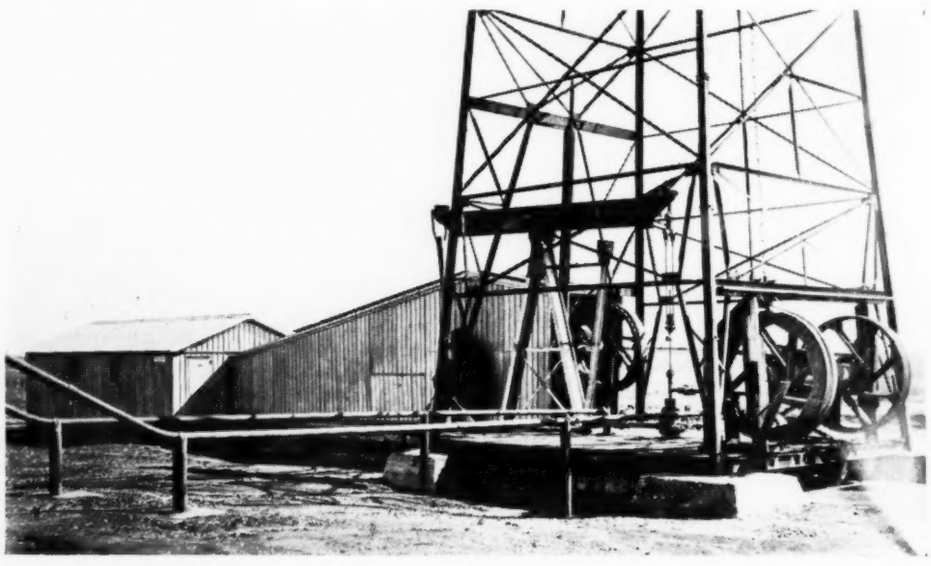
The well's prime mover is a 12x12 steam engine which transmits power to the bandwheel by direct belt drive. The well is operating on a 54-inch stroke at 16 to 18 strokes per minute. It is heavily counterbalanced with the rotary type balance and all rig irons are of heavy steel, as is the walking beam, which is equipped with a straight lift beam hanger for the sucker rods.

A 1¾-inch x 12-foot working barrel is set at 6,500 feet, or 146 feet off bottom. The well originally was drilled to 6,696 feet, but encountered water and was plugged back to its present depth of 6,646 feet. It is tubed with 2½-inch upset tubing and has ⅞-inch sucker rods with 1 5/16-inch box and pin.

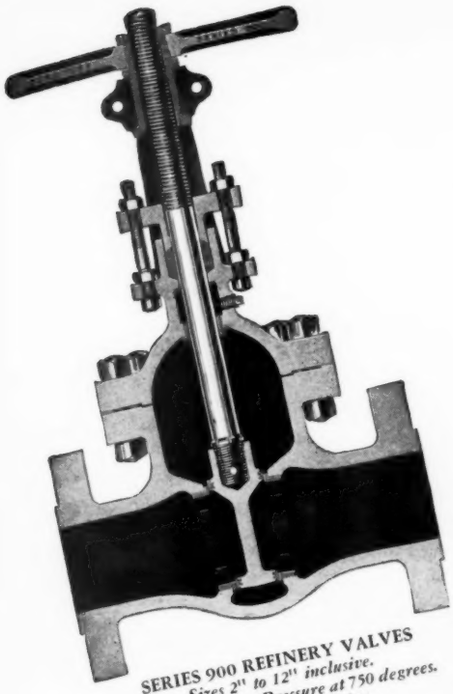
The well makes some gas and this probably helps to some extent its pumping efficiency, although the gas is not shut in at the casinghead.

All installations for pumping in the field will necessarily be of the heavy duty type because of the great depths of the wells. In preparation for the severe pumping service, which is anticipated, the main sills and all machinery supports around the rig have been firmly embedded in concrete on the wells now partly prepared for pumping.

All the wells thus far have been equipped with steel walking beam, pitmans, and the majority, with steel bandwheels. Prime movers include steam engines, twin gas engines and electric motors, many of which are now being used in cleaning out work.



Continental Oil Company's No. 5 Vincent Sudik, showing pumping equipment.



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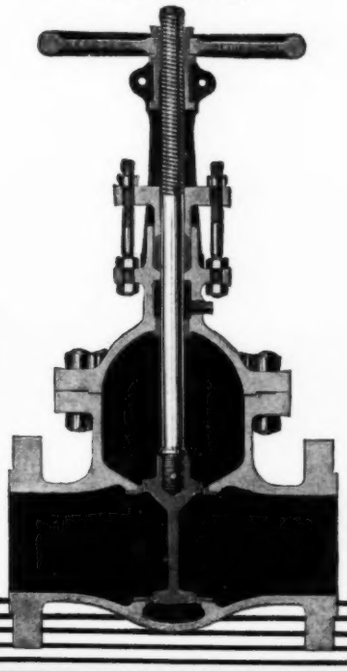

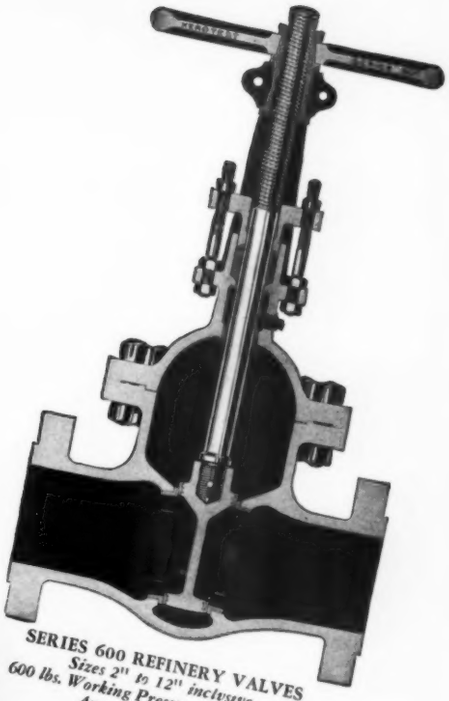

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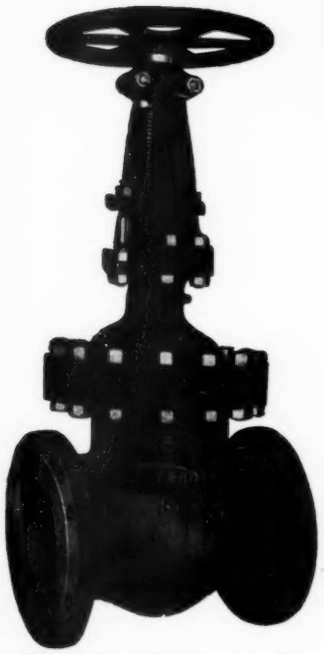

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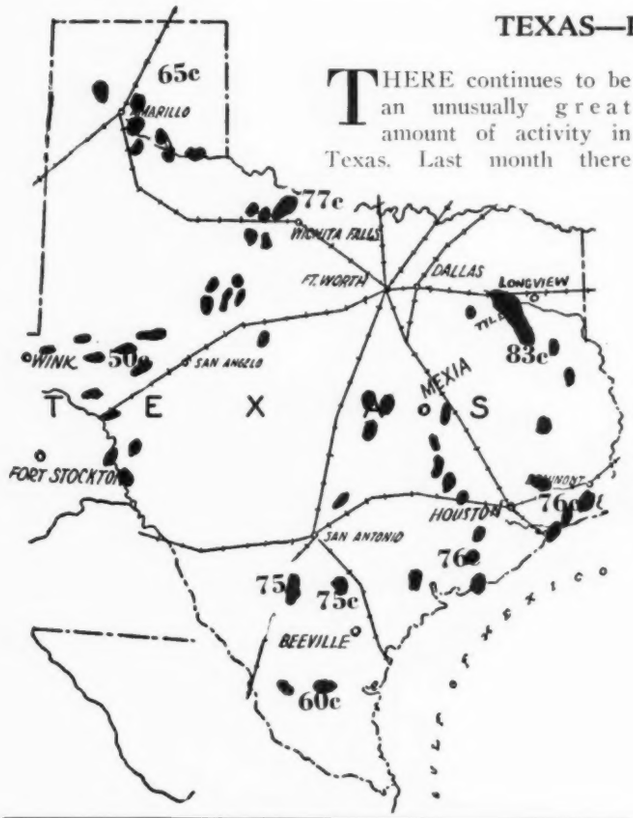
Latest Activities *in the* Oil Fields*

TEXAS—Production, 1930—290,720,000 Barrels



THERE continues to be an unusually great amount of activity in Texas. Last month there were 731 permits or locations and 658 completions. At the close of the month the state had 309 rigs and 835 drilling tests.

The East Texas area accounts for most of the drilling and at present there is no indication of a let-up in the number of operations in this big field, which at this time outranks any other field in the Nation.

Following is a tabulated review of the active areas:

	POOLS			
	East Texas	Panhandle	Van	Refugio
Number of Permits	546	2	8	2
November Completions	541	4	4	1
Number of Rigs	89	15	6	2
Number Drilling Wells	571	24	8	3
Gravity of Oil	40	40	36	26
Depth of Production	3600	2900	2600	6500
Type of Tools Used	Rotary	Rotary	Rotary	Rotary
Number of Casing Strings	2	2	2	2

CALIFORNIA

Production, 1930—228,612,000 Barrels

TWENTY-TWO tests were completed in California during the month of October, during which time 23 new locations were staked. The state had 18 rigs and 180 drilling tests at the close of the month.

California continues to follow closely all proration orders and has no new field developments that are threatening to break away from the regular development of all fields that has been so successful.

Following is a survey of activities.

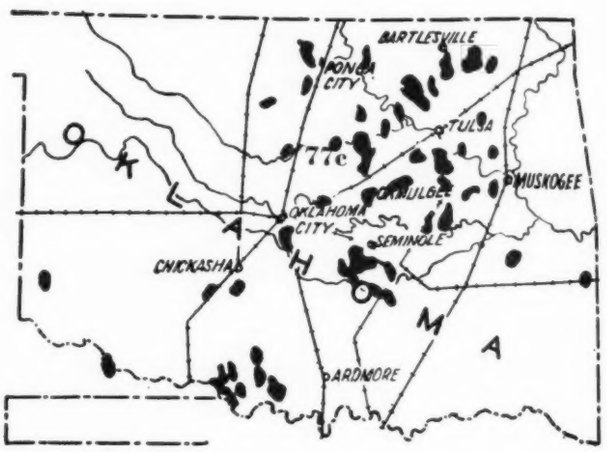
	POOLS			
	Playa Del Rey	Long Beach	Kettleman Hills	Ventura
Number of Permits	0	2	3	2
November Completions	1	5	2	4
Number of Rigs	0	1	2	1
Number Drilling Wells	2	3	9	7
Gravity of Oil	23	26	60	36
Depth of Production	6000	7000	8300	7800
Type of Tools Used	Rotary	Rotary	Rotary	Rotary

*All statistics as of December 1st.

● Denotes oil and gas fields.

OKLAHOMA

Production, 1930—214,425,000 Barrels

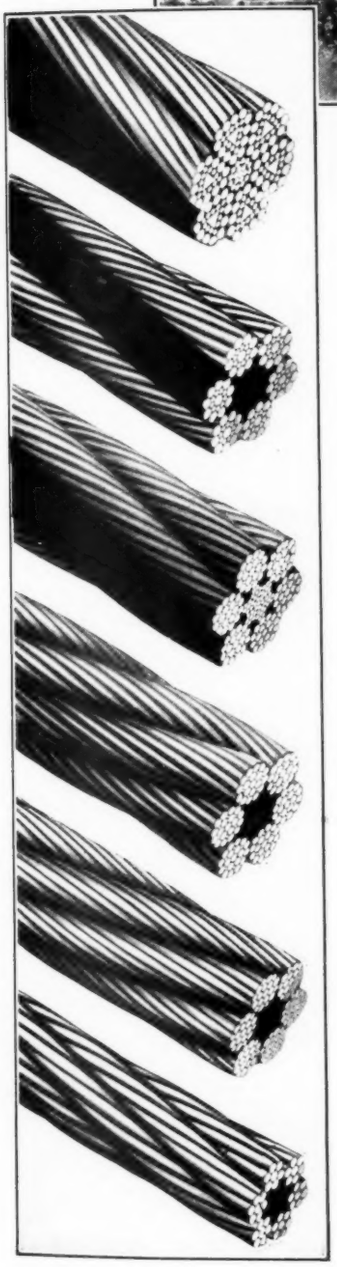


A slight increase in the number of drilling wells was registered in Oklahoma last month. This is the first increase the state has shown in many months.

Following is a summary of Oklahoma's activity:

	Entire State	Oklahoma City
Number of Permits	64	11
November Completions	47	14
Number Rigs	45	11
Number Drilling Wells	107	28
Gravity of Oil	36 (average)	39
Depth of Production	Varies	6400
Type of Tool Used	Cab.-Rot.	Rotary
Number of Casing Strings	Varies	3

Figures on maps indicate average prices of crude oil per bbl.



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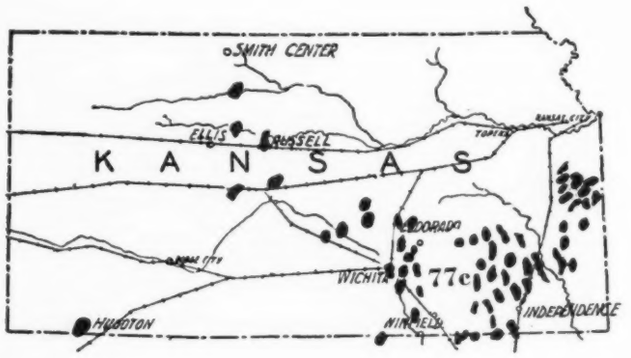
KANSAS—Production, 1930—41,745,000 Barrels



Kansas had 28 completions, 39 permits for drilling, 41 rigs and 69 drilling wells in November. Both rotary and cable type tools are used in the state, with the latter type predominating. Interest in the state is now being attracted to the central west area, where some widely scattered producers have been completed.

Following is a summary of the active fields:

POOLS

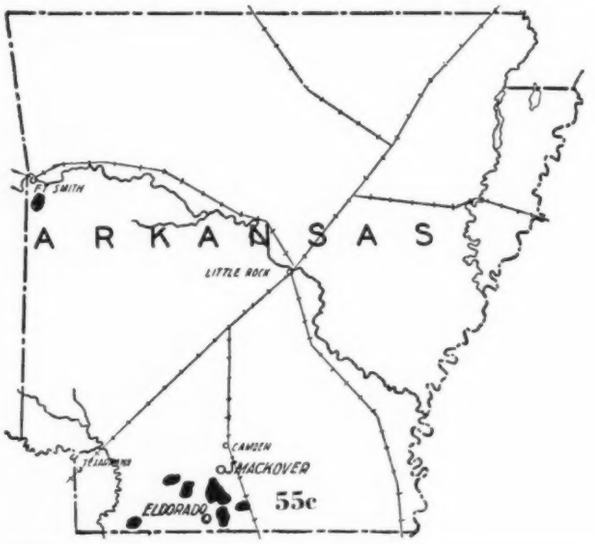
	Sedgwick County	McPherson County
Number of Permits	7	10
November Completions	1	14
Number of Rigs	4	13
Number Drilling Wells	10	21
Gravity of Oil	39	38
Depth of Production	2900-3500	2900-3400
Type of Tools Used	Cab.-Rot.	Cab.-Rot.
Number of Casing Strings	2	2

ARKANSAS

Production, 1930—19,680,000 Barrels

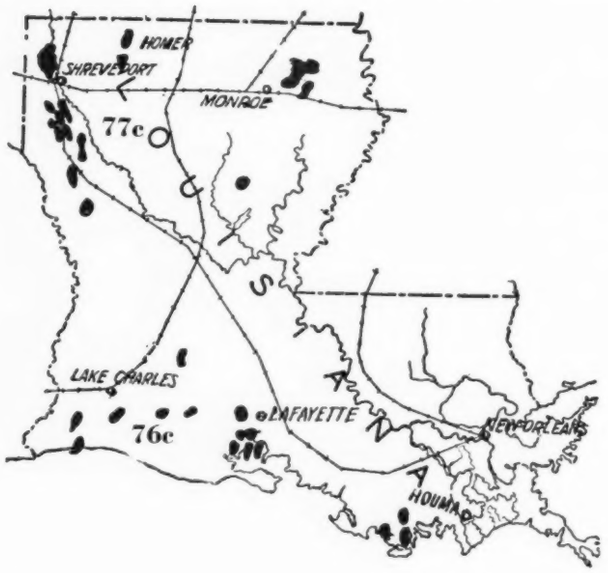
Four new drilling permits, two completions, seven rigs and 28 drilling wells comprise the oil field activity in Arkansas for the past month.

Drilling is accomplished in this state with rotary type tools. The formations penetrated frequently carry large gas pressures and are ordinarily soft and cavey.



LOUISIANA

Production, 1930—23,150,000 Barrels



Louisiana had 27 new permits and 17 completions during November. The state has 13 rigs and 75 drilling tests within its boundaries. Rotary tools are operated in both the Gulf Coast and North Louisiana regions.

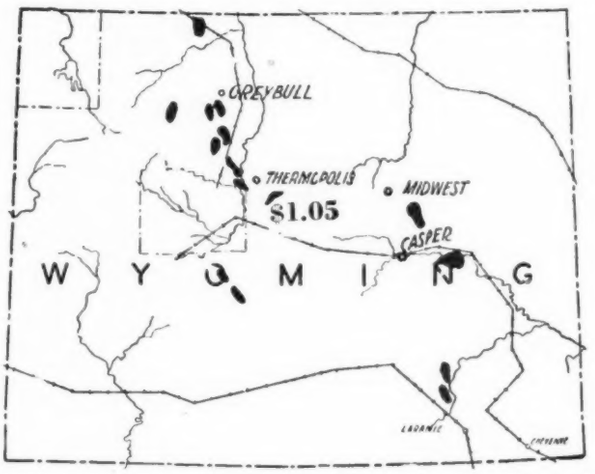
Five wells were completed in Mississippi, east adjoining neighbor of Louisiana. This area has 11 rigs and 20 drilling tests. The Jackson gas area is the center of most of the activity.

●Denotes oil and gas fields.

WYOMING

Production, 1930—11,177,000 Barrels

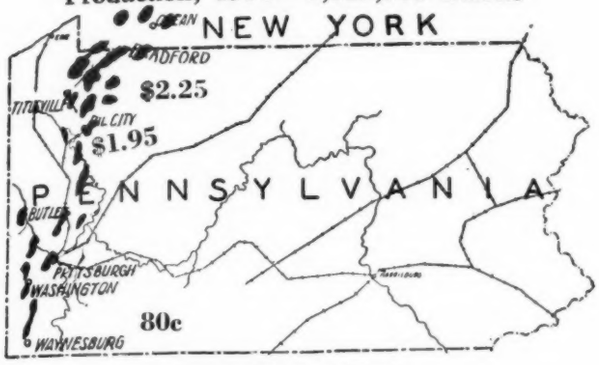
Completions in Wyoming totaled six during the past 30 days, activity consisted of 9 rigs and 75 drilling tests. Practically all tests are drilled with cable tools.



Figures on maps indicate average prices of crude oil per bbl.

NEW YORK

Production, 1930—3,825,000 Barrels



PENNSYLVANIA

Production, 1930—12,810,000 Barrels

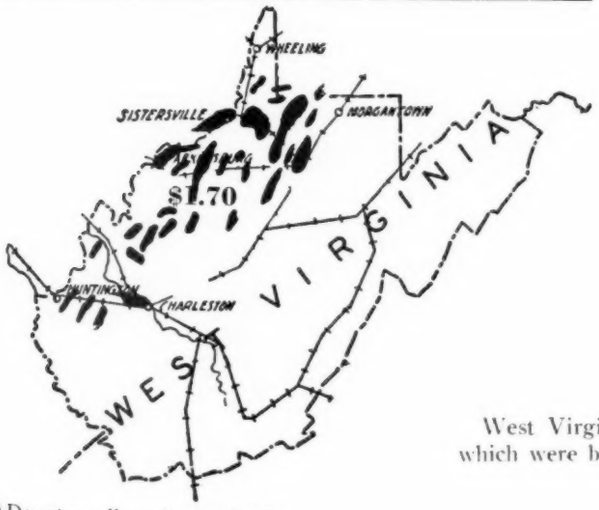
A total of 16 tests were completed in Pennsylvania, while New York had six completions. The two states have 26 rigs and 140 drilling tests. Drilling in both areas is conducted with cable type tools.

ILLINOIS

Production, 1930—5,695,000 Barrels

There were 2 tests completed in Illinois during November, while two rigs and 18 drilling wells comprised other field operations.

Standard tools are used by operators to drill the oil tests in the state, where producing horizons are shallow and usually easily reached.

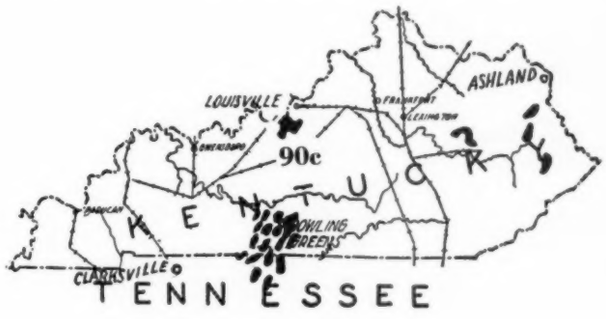


● Denotes oil and gas fields.

KENTUCKY

Production, 1930—7,300,000 Barrels

Kentucky had 19 completions last month, during which time there were 10 rigs and 73 drilling tests. Tennessee did not have a completion and had but 14 drilling tests. Standard tools are used by operators in both states.



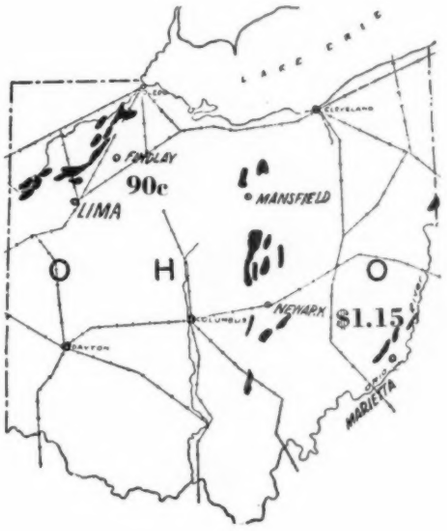
TENNESSEE

Production, 1930—20,000 Barrels

OHIO

Production, 1930—6,525,000 Barrels

Ohio had 103 tests completed, 31 rigs and 108 drilling wells last month. The central area continues to be the most active, having 29 rigs and 93 drilling tests. Cable tools are utilized for drilling purposes.



WEST VIRGINIA

Production, 1930—5,100,000 Barrels

West Virginia had 18 completions, 15 rigs and 45 drilling tests, all of which were being drilled with cable tools.

Figures on maps indicate average prices of crude oil per bbl.

NEW MEXICO

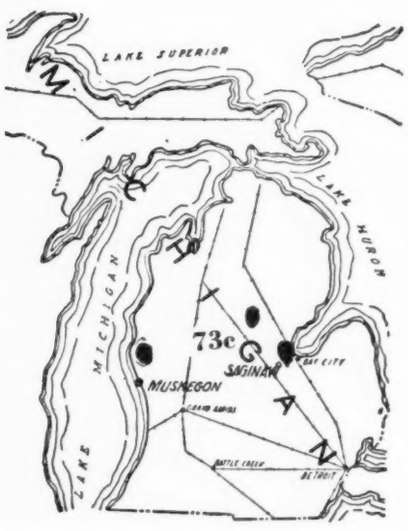
Production, 1930—10,235,000 Barrels

There continues to be a lull in field activity in this state. In November there were four completions, five rigs and 54 drilling tests in the state. There, however, remains much interest in the state and it is likely to get a thorough testing when conditions improve.

The Hobbs field, although practically shut in by proration order, is the most active area. This field has been developed with rotary tools and offers difficult drilling conditions because of heavy pressures found in upper sands.

MICHIGAN

Production, 1930—3,525,000 Barrels



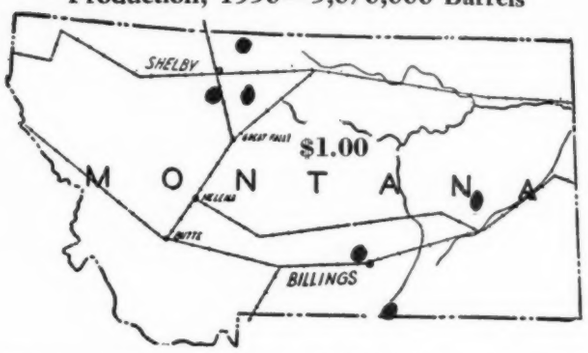
Seventeen tests were completed in the state of Michigan during the month of November, 68 rigs were listed on the state's activity report and there were 96 tests drilling.

Operators of the state do their drilling with cable tools, except in a few instances when rotary tools have been used.

● Denotes oil and gas fields.

MONTANA

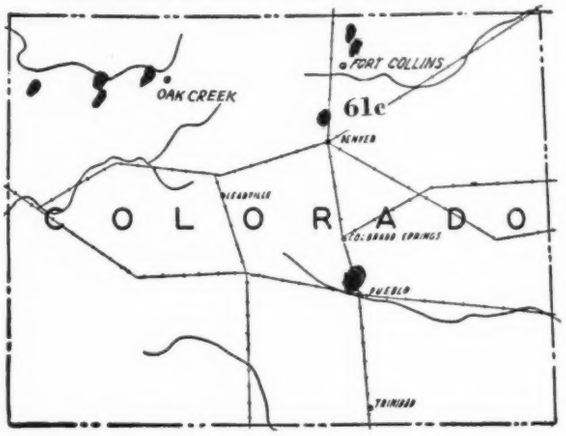
Production, 1930—3,070,000 Barrels



Three completions, 17 rigs and 70 drilling tests comprised the oil field activity in Montana last month. Cable tools are the most common method of drilling.

COLORADO

Production, 1930—1,644,000 Barrels



Two wells were finished in Colorado in November. Drilling activity is composed of 13 rigs and 84 drilling tests. Both rotary and cable tools are used in the state.

INDIANA

Production, 1930—1,000,000 Barrels

During November Indiana had three completions and seven rigs and 56 drilling tests in its oil fields.

Producing sands in the state are shallow and are easily and quickly reached, contractors use standard type tools for all drilling operations.

Figures on maps indicate average prices of crude oil per bbl.

The Petroleum Engineer

Wishes you a

Merry Christmas

and a

Prosperous 1932

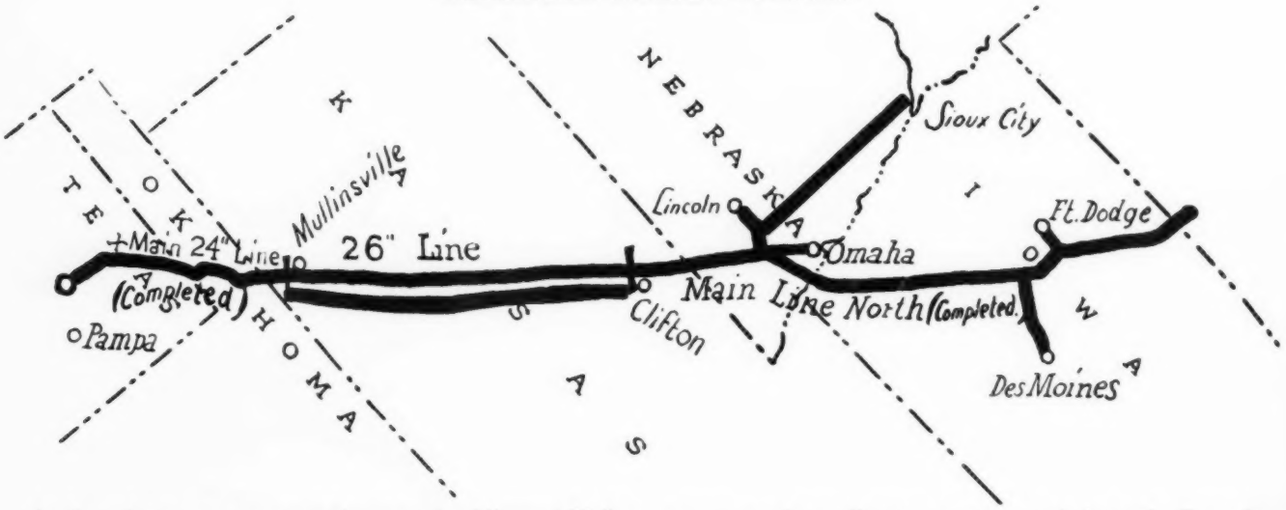
Progress of Major Pipe Line Work

By J. H. DAMERON

WITH pipe line companies winding up their current construction work numerous reports are filtering through the trade of various major projects that are expected to be started in 1932. These reports involve oil, gas and gasoline lines in main line work and lateral construction. Some of the reported new construction work is expected to be started soon after the first of the year, while several other companies are reported to be planning new work to begin late in the spring of 1932.

In the meantime several smaller construction jobs are in progress in various parts of the country and construction work has been resumed on the Lycoming 110-mile 20-inch coupled line in Pennsylvania and New York. Right-of-way difficulties are holding back construction work in a few localities, but these barriers will probably be broken down before the winter season ends. In the northwest several projects are in the formative stage and one or more of these may be started soon.

MISSOURI VALLEY P. L. CO.

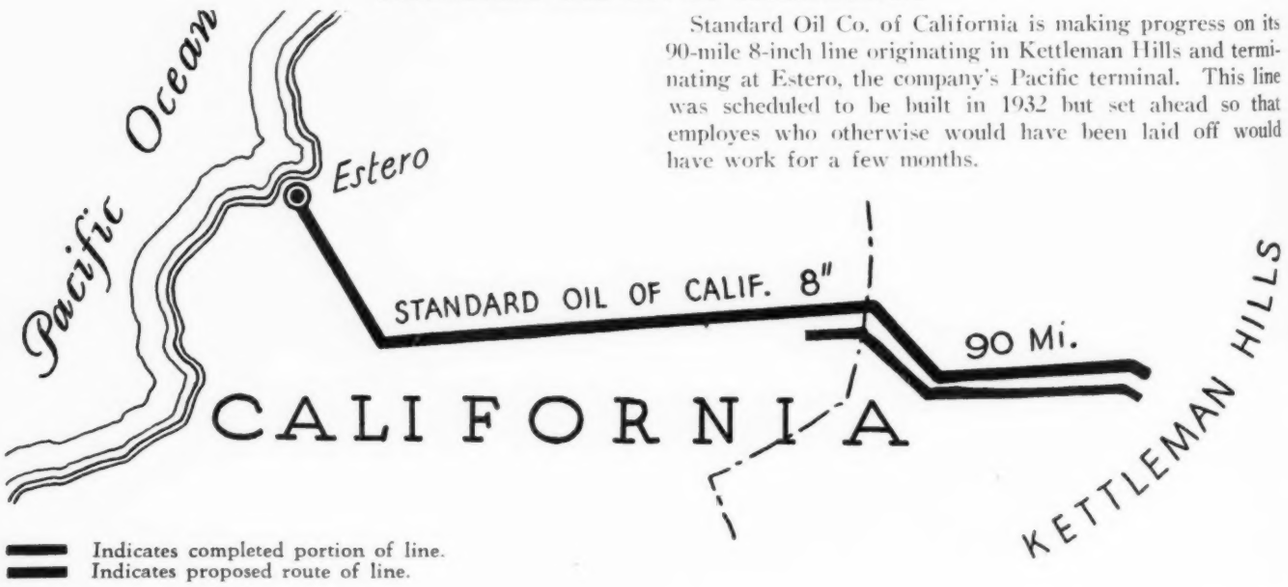


As the winter season gets under way the Missouri Valley Pipe Line Co., Omaha, Nebr., completed its major construction work scheduled for 1931. This includes the construction of approximately 200 miles of welded and coupled 26-inch line in Kansas. This section was built by Smith Bros., Dallas, Texas, contractors and gives the transporting company a large diameter system north from the Texas Panhandle to North Omaha.

As this work was completed Fredell Construction Co. completed a 90-mile 14-inch extension of the line into Sioux Falls and Truman Smith Construction Co. wound up construction work on a 65-mile 16-inch extension into Minnesota.

STANDARD OIL CO. OF CALIFORNIA

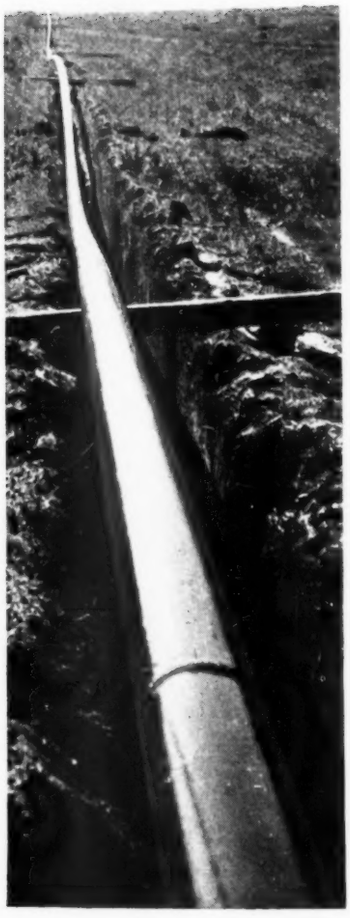
Standard Oil Co. of California is making progress on its 90-mile 8-inch line originating in Kettleman Hills and terminating at Estero, the company's Pacific terminal. This line was scheduled to be built in 1932 but set ahead so that employes who otherwise would have been laid off would have work for a few months.



Indicates completed portion of line.
Indicates proposed route of line.

ON THIS LINE EACH WELDER

MADE 60 TO 70 WELDS A DAY



ON a Lindewelded natural gas line in Texas, each welder averaged 60 joints a day on 6 5-8 in. pipe, and 70 on 5 1-2 in. pipe.

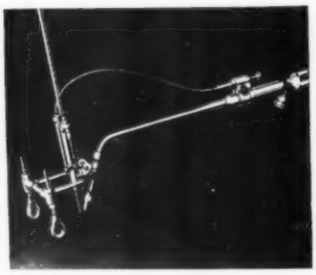
This record is not unusual. Lindewelding with an ordinary blowpipe lowers welding time 30 to 60 per cent. and lowers consumption of welding materials 35 to 40 per cent. With a special Lindewelder blowpipe, speed is further increased and welding becomes almost automatic.

Pipe lines laid by this new method of oxy-acetylene welding pass every test. Lindewelds are permanently strong and tight.

Procedure Controls for Lindewelding are available to all Linde customers through Linde Process Service. Consult our nearest district office for complete information.

See the Actual Steps in Lindewelding

Lindewelding technique differs from the neutral flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. Our motion picture, "The Lindeweld Process for Pipe Line Construction," reveals the actual steps in making a Lindewelded joint. This picture, furnished in 16 mm. and 35 mm. safety film, will be loaned free of charge to pipe line officials and welding or engineering societies. You can obtain it by writing to any Linde District Office.



THE LINDEWELDER

A special appliance which further increases the speed of Lindewelding, and makes the welding operation almost automatic.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants UCC 627 Warehouse Stocks

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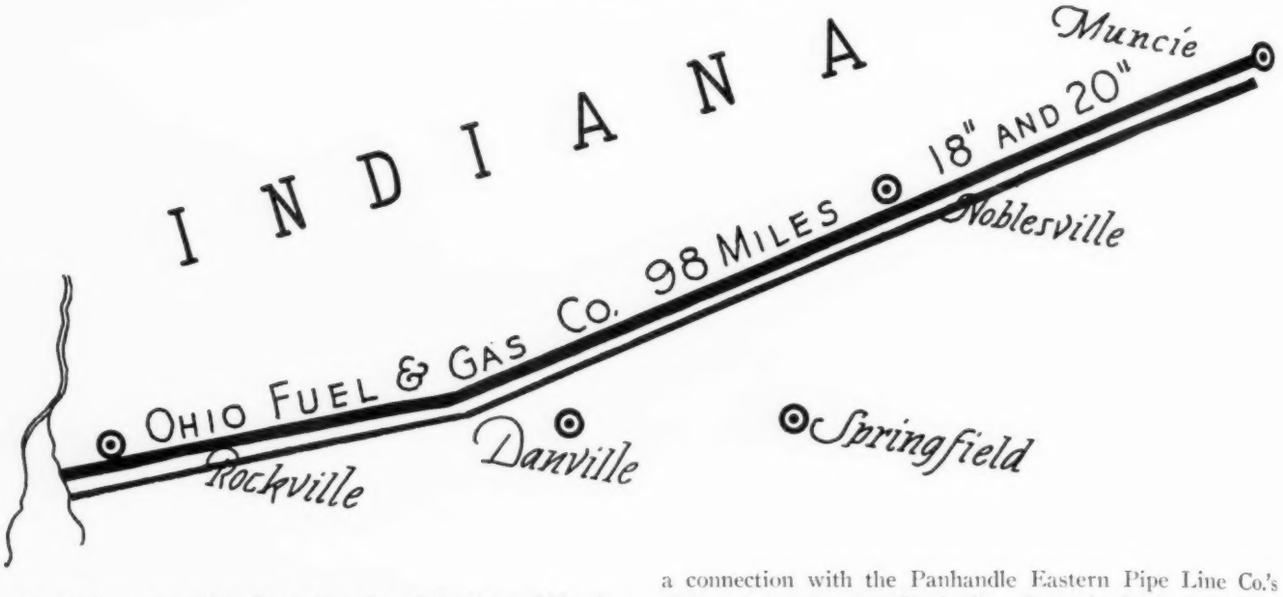
Boston	Indianapolis	St. Louis
Buffalo	Kansas City	Salt Lake City
Chicago	Los Angeles	San Francisco
Cleveland	Milwaukee	Seattle
Denver	Minneapolis	Tulsa

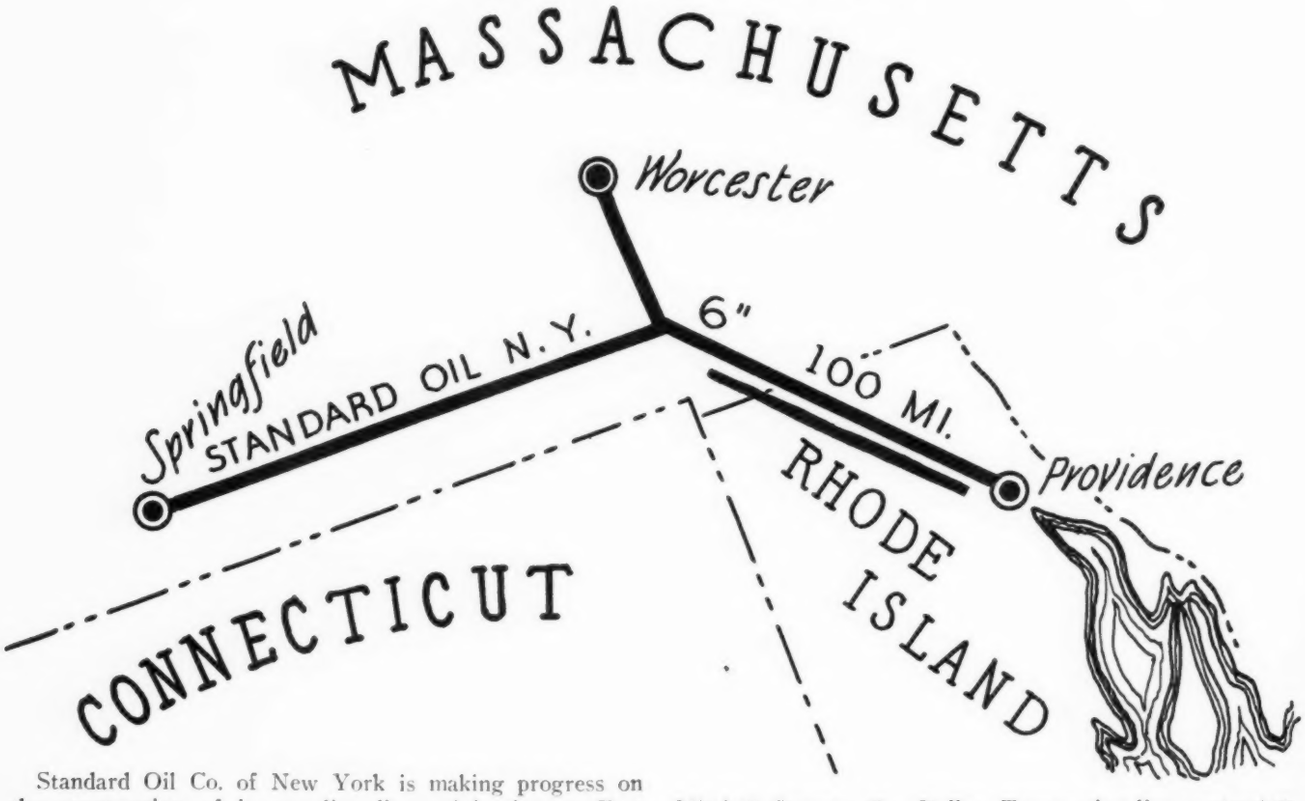
LINDE OXYGEN · PREST-O-LITE ACETYLENE · OXWELD APPARATUS AND SUPPLIES · UNION CARBIDE

OHIO FUEL GAS CO.



In Indiana the Ohio Fuel Gas Co., Columbus, Ohio, has completed construction of its 98 miles of 18 and 20-inch combination welded and coupled line starting at a point near Rockville, Ind., and terminating at Muncie. The line makes a connection with the Panhandle Eastern Pipe Line Co.'s system at a point near Rockville. Both the Panhandle Eastern and Ohio Fuel Gas Co. are affiliated with the Columbia Gas & Electric Co. and the Muncie project connects the two vast systems.

STANDARD OIL CO. OF NEW YORK



Standard Oil Co. of New York is making progress on the construction of its gasoline line originating at East Providence, R. I., and terminating at Springfield, Mass. Mitchell Stewart Co., Dallas, Texas, pipe line contractors, were awarded the contract to build the welded carrier.

Indicates completed portion of line.
Indicates proposed route of line.

The WORLD'S LONGEST GASOLINE LINE

Great Lakes project involves 1400 miles

THE longest gasoline line in the world is that of the Great Lakes Pipe Line Company, recently completed, leading from northern Oklahoma points and El Dorado, Kansas, through Kansas City to Des Moines and branching from the latter north to the Twin Cities and east to Chicago. South of Des Moines another branch extends to Omaha. A total of 1400 miles is involved and 27,500 barrels per day is the estimated capacity. It has twenty-one pump stations at intervals of approximately fifty miles. Terminals and blending stations for Ethyl gasoline are located at Kansas City, Des Moines, Chicago, Twin Cities and Omaha. The system has its own telegraph and telephone lines from end to end and also teletype equipment like that used for the transmission of news to metropolitan newspapers.

Six oil companies united in the Great Lakes enterprise and are sharers in ownership of the line. Numerous firms of contractors were employed in laying the line and in building the pumping stations. Altogether this was one of the outstanding pipe line projects of the year and with additional extensions contemplated, the line will serve an unusually large area.

For this very important undertaking the pipe used throughout, was NATIONAL—

America's Preferred Line Pipe

NATIONAL TUBE COMPANY · PITTSBURGH, PA.

Subsidiary of United States Steel Corporation

NATIONAL PIPE

PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
O. L.	Ajax Pipe Line Co	Springfield, Ill.	Glenn Pool, Okla	Wood River, Ill	10"	400	Making plans to parallel existing 2-10" with third 10".
G. L.	Arkansas Valley P. L. Co	Colorado Springs, Colo	Central, Colo.	Various cities in Colo	6"	40	Making extensions of Colo. system.
Ga.L.	Atlantic Refg. Co.	Philadelphia, Pa.	Point Breeze	Wilkes-Barre, Pittsburgh	6-8"	475	Mitchell Stewart Co. building line.
Ga.L.	Bivens, C. E., et al	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932.
G. L.	Continental Constr. Corp	Chicago, Ill.	Geneseo, Ill.	Rockford, Ill.	20"	86	Receiving bids.
G. L.	Columbia Gas & Elec. Co	New York, N. Y	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line.
G. L.	Continental Constr. Corp	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp	Chicago, Ill.	Point in Ill.	Milwaukee, Wis.	20"	160	Buying right of way.
G. L.	Continental Constr. Corp	Chicago, Ill.	Texas Panhandle	Chicago, Ill.	24"	1000	Plan to start parallel present line in 1932.
O. L.	Continental Oil Company	Ponca City, Okla	Greasewood Flats, Colo	Denver, Colo.	6"	70	Proposed—making cost survey.
O. L.	Continental Oil Company	Ponca City, Okla	Greasewood Flats, Colo	Hardin	4"	16	Building 15-car rack at Hardin and one 5,000-bbl. tank.
Ga.L.	Great Lake Pipe Line Co	Kansas City, Mo	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Plan to loop and add 3 units to each sta. or build automatic booster station.
O. L.	Gulf Pipe Line Co	Tulsa, Okla.	Tulsa, Okla.	Spencerville, Ohio	10"		Plan looping present line and increasing station capacity.
G. L.	Iroquois Gas Company	Buffalo, N. Y	Wayne Field, N. Y	Buffalo, N. Y	6"	60	Under construction.
G. L.	International Util. Corp	New York, N. Y	Alberta, Canada	Vancouver, B. C	20"	500	Plan $30,000,000 project via Portland, Ore. D. E. Lamb, Portland rep.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo	Seattle, Wash.	20"	500	Proposed.
G. L.	Kansas Communities Gas Co	Chanute, Kans.	Local field	Chanute, Kan.	6"	15	Plan short local line and field station.
G. L.	Kansas Pipe Line & Gas Co	Salina, Kans.	Grantville, Kan.	Atchison, Kan.		40	Plan to start construction soon.
G. L.	Lycoming Nat. Gas. Corp	New York, N. Y	Tioga Field, N. Y.	Syracuse, N. Y	20"	100	Resumed construction.
G. L.	Lewiston Nat. Gas Co	Lewiston, Mont.	Armells Structure, Mont	Mont. towns	4-6"	100	Proposed.
G. L.	Missouri Valley P. L. Co	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed.
G. L.	Montana-Dakota Power Co	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co	San Francisco, Calif					Have appro. for $2,000,000 expansion campaign.
Ga.L.	Phillips Pipe Line Co	Bartlesville, Okla.	Texas Panhandle	St. Louis, Mo	8"		Plan to build 4 booster sta. and build 50 miles of line.
O. L.	Stanolind Pipe Line Co	Tulsa, Okla.	Mid-Continent	Chicago, Ill.	8-10"	360	Looping 360 mi. of existing line and increasing station capacity.
Ga.L.	Sun Pipe Line Company	Philadelphia, Pa.	Point in N. Y	Lake Ontario	6"	45	Extending to tidewater terminal.
G. L.	Southern Nat. Gas Corp	Birmingham, Ala.	(See Remarks)				Reported planning extension to Chattanooga, Tenn.
O. L.	Texas Empire Pipe Line Co	Tulsa, Okla.	Okla. City, Okla	East Texas	10-12"	250	Pur. right of way for oil line to East Texas pipe inquiry out.
O. L.	Tex-York Utilities Corp	New Orleans, La	East Texas	New Orleans, La	8"	400	Proposed.
G. L.	United Public Service Co	Houston, Texas	(See Remarks)		4-6-8"	100	Extending main line in So. Louisiana.
G. L.	United Public Service Co	Houston, Texas	Austin	Wichita Falls	20"	240	Rumored plan extension of main line system.
Ga.L.	White Eagle Oil Co	Augusta, Kan.	Augusta, Kan.	Kansas City Mo.	8"		Considering construction of Gasoline line.
Ga.L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.
O. L.	Yount-Lee Oil Company	Beaumont, Tex.	High Island	Spindle top	10"	45	Building oil outlet to Spindletop storage.
O. L.	Texas Royalty Owners & Producers P. L. Co	Tyler, Texas	East Texas	Houston, Texas	12"	200	Applied to Texas "Blue Sky" Commissioner for permission to sell stock.

TABLE

O. L.—oil line
G. L.—gas line
Ga. L.—gasoline line

THE SERVICE that eliminates waste is a valued service to any industry.

Petreco has eliminated the wanton waste of "cut oil" in the Petroleum Industry continuously now for more than two decades; more efficiently, more economically, and more dependably than otherwise would have been possible.

Whether you have "cut oil" problems now or not, you should know about them, and their solution. Write us for Bulletin No. 30-3 — "The Petreco Process for the Electrical Dehydration of Crude Oil Emulsions."

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Fully covered by process and apparatus patents

The Month's Activities *in* Refining*

By F. R. STALEY

REFINING operations decreased during the past month in eastern and western divisions and slightly increased in the central divisions.

The M. W. Kellogg Co. was awarded a contract for a 6,500-barrel cracking unit to be erected in the Standard Oil Company's refinery at Casper, Wyo.

Winkler Koch Engineering Co. is building a reforming unit for the Garber Refining Company.

The Marathon Oil Company will make extensive changes in its refineries in Fort Worth, Texas, and in Brostow, Okla.

The Continental Oil Company is building a new naphtha recovery system in its Ponca City refinery.

The Simrall Refining Corp. will build a small refinery at Amherstburg, Ont.

The Producer's refinery at Bristow, Okla., will build a new cracking unit and a gasoline recovery plant.

The Atlantic Refining Co. will spend $3,000,000 improving cracking units in its Eclipse plant at Franklin, Pa.

Many papers of interest to refiners were presented at the annual meeting of the American Petroleum Institute in Chicago. Paraflow, a hydrocarbon product, developed by the Standard Oil Development Company, was described in a paper by Davis and Blackwood. The addition of a fraction of a per cent of this product to certain grades of motor oils is said to eliminate the necessity for removing excess wax, and renders the oil perfectly fluid at temperatures below the natural pour point of the oil. Paraflow is now being produced on a commercial scale for refiners licensed to use it.

T. A. Boyd presented a report of progress in the work of the Detonation Sub-committee. The progress made during the past year toward uniformity in knock testing was thoroughly described. The term octane number is defined and illustrated, and the octane number scale is explained in this paper.

A paper on Gasoline Vapor Pressures by Bridgeman, White and Gary states that the final solution of the vapor-lock problem lies in the observance of the two rules: keep heat out of the fuel system, and keep propane out of the gasoline.

A new method of refining gasoline in the vapor phase with a solution of zinc chloride was described in a paper by Arthur Lachman.

Other important papers were J. Bennett Hill's on the Institute's Fundamental Research, Extreme-Pressure Lubricants by Mougey and Almen, and State Specifications for Gasoline by K. G. Mackenzie.

Natural Gasoline

Crosbie and Moran, Inc., of Tulsa, Okla., will build a gasoline plant on the Isaac Reynolds survey in the Kilgore area.

G. G. Oberfell, president, has announced a change in the name of Philfuels Company to Philgas Company.

Julio Canessa presented a paper on Butane Plants before the California Natural Gasoline Association, December 10th.

The Natural Gasoline Supply Men's Association elected the following officers for the coming year: A. W. Burckett, president; W. D. Moorer and A. V. B. Candler, vice-presidents; Ray Miller, secretary; E. H. Triphaus, treasurer; J. H. Satterwhite, chairman of membership committee.

Figures in red show per cent refining capacity operated.

*All statistics as of December 1st.

FILLS AN IMPORTANT PIPING NEED

WELDING ELLS

made from

Reading *Puddled Iron

FOR the many jobs where genuine wrought iron pipe is advantageous—and where welding assures a better or cheaper installation than other methods of connecting pipe—Midwest now offers welding ells made from genuine Reading Puddled Iron skelp. At present, the sizes are from 2″ to 10″ inclusive; both standard weight and extra heavy are available.

Midwest *Genuine Wrought Iron Welding Ells—like those made from mild steel pipe material—have a number of distinctive and important advantages. Prominent among these are *dimensional accuracy* and *uniformity*—the ells have full and true circular cross sections and are to exact radius. This results from a special *compression* sizing operation that is exclusive with Midwest. The manufacturing procedure also holds the wall thickness uniform and within very close tolerances; this thickness is never less than the nominal pipe wall thickness.

The included angle of every Midwest Welding Ell is exactly 90° or 45° and center-to-face dimensions are accurately maintained—because of ingenious fixtures used in machine-beveling the ends. Inspection is very rigid and each ell is subjected to a hydrostatic test pressure 25% greater than the mill test of the corresponding pipe.

Long tangents are another distinctive advantage—the pipe and fitting can be lined up more quickly and accurately. One quarter inch of tangent is provided for each inch of fitting diameter; thus an 8-inch ell has tangents 2 inches long. Particularly in the larger sizes, an appreciable saving results from the decreased length of pipe required.

Each Midwest Welding Ell is made from *one piece* of Reading Puddled Iron skelp by a special process developed and patented by Midwest; there is one welded longitudinal seam along the inner circumference. The final working of the fitting is in *compression* at a forging heat, thus normalizing and refining the skelp and the weld—it is not extruded or stretched.

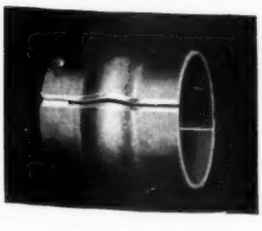
Since these Midwest Welding Ells are made from Reading Puddled Iron skelp, they have the same corrosion resistance, the same coefficient of expansion and the same welding characteristics as *genuine wrought iron pipe.

Get in touch with the nearest Midwest office for complete information regarding Midwest *Genuine Wrought Iron Welding Ells.

Midwest Piping & Supply Co., Inc.

Main Office: 1450 South Second St., St. Louis

Offices: Chicago, 208 South La Salle Street . . . Houston, 600 Bringhurst Street . . . Los Angeles, 520 Anderson Street . . . New York (Ballwood Division), 30 Church Street . . . Tulsa, 733 Mayo Building



MIDWEST WELDING SLEEVE

Used to reinforce a butt line weld between two pieces of pipe, it relieves the butt weld of any bending stress and much of the tensile stress to which it would otherwise be subjected. Transverse recess in sleeve permits its application over the conventional butt ine weld. Sleeves are carried in stock from 4″ to 24″.

MIDWEST WELDING SADDLE

It not only reinforces the junction of neck and body of a welded header, but also compensates for the weakening of header body that results from loss of the meta l cut out for the neck opening. Tests proved this saddle materially increases the strength of a welded header over customary gusset plate construction. Made in sizes from 4″ x 2″ to 24″ x 24″.

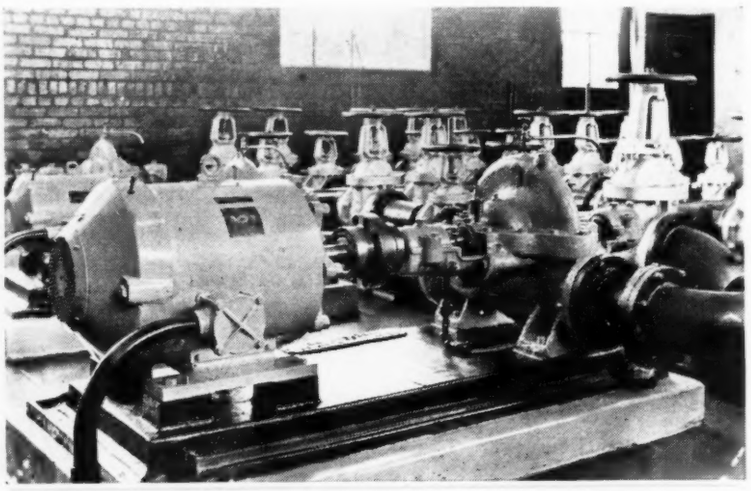
THE ETHYL BLENDING PLANTS *of the* GREAT LAKES PIPE LINE COMPANY

H. R. BERG*

WITHIN the last two years the increasing sales of Ethyl gasoline have resulted in the development of equipment for blending Ethyl fluid with gasoline in large volume, with a high degree of accuracy, and with a minimum handling of the fluid.

The Ethyl Gasoline Corporation had anticipated the fact that the gallonage of Ethyl Gasoline would become so great that the old drum type mixing installations would no longer be adequate and that a mixing installation enabling rapid, accurate blending of large volumes of gasoline would be necessary.

Until two years ago Ethyl fluid was shipped to refiner licensees in 50-gallon steel drums, a method fast becoming prohibitive due to the large number of drums required, resulting in laborious, time-consuming handling of the heavy containers. Aside from the problems arising at the producing and shipping point, the handling of Ethyl fluid drums at the blending plant had become burdensome. Drums had to be unloaded from the cars, stored, and, when a mix was being made, rolled up in succession in position on the mixing platform, emptied, washed out and removed. This also called for extreme care in handling, constant mopping up and cleaning away spills. The further objection was that as a partial drum could not be used, the amount of gasoline being blended had to be gauged to the number of drums of fluid used.



Interior of pump house.

It was to meet these objections, as well as to design a more efficient and rapid blending plant, that the Ethyl Gasoline Corporation designed the present equipment for handling Ethyl fluid in tank cars. Today Ethyl fluid is being shipped to the blending station in specially designed tank cars. The Ethyl Gasoline Corporation owns and maintains its own fleet of these cars, some of 3,000 and some of 6,000-gallon capacities. A description of the equipment and operation of one of these new tank car Ethyl blending plants should be of interest to everyone associated with the refining industry. A typically new and up-to-date blending installation is that of the Great Lakes Pipe Line Company's Ethyl plant located at its Kansas City (Kan.) station.

The blending equipment is located in a substantial one-story, fireproof building of pressed brick and stone construction and presents a very attractive appearance. This building also houses an office, laboratory and pump house containing centrifugal pumps serving the loading rack, and a centrifugal Ethyl Gasoline circulating pump. The last-named is used in turning over the Ethyl gasoline storage tanks, after the blend is made, to secure a perfect and uniform mixture, or finished product.

The Ethyl blending equipment occupies a separate room, isolated from the other parts of the building, and forms a complete separate unit. On entering this Ethyl room a visitor is immediately impressed with an atmosphere of cleanliness and order. The walls and floor are white, all equipment and piping are painted with aluminum; in fact, the visitor might imagine himself in a dairy instead of in a gasoline manufacturing establishment. However, this white and spotless condition is not maintained for sanitary reasons alone. Its prime purpose is a practical one. As Ethyl fluid contains part of the red coloring matter used to give Ethyl gasoline its red color, detection of leaks becomes an easy matter. Any red stain means Ethyl fluid and calls for immediate attention. Avoidance of leaks, spills and any possible health hazard due to exposure to the concentrated tetraethyl lead is thus easy to avoid and eliminates the necessary but troublesome frequent changes of the white uniforms and gas masks used in a drum mixing plant. In a modern blending plant like this it is unnecessary to see the Ethyl fluid, marking a distinct advantage of an installation of this type over the earlier drum type.

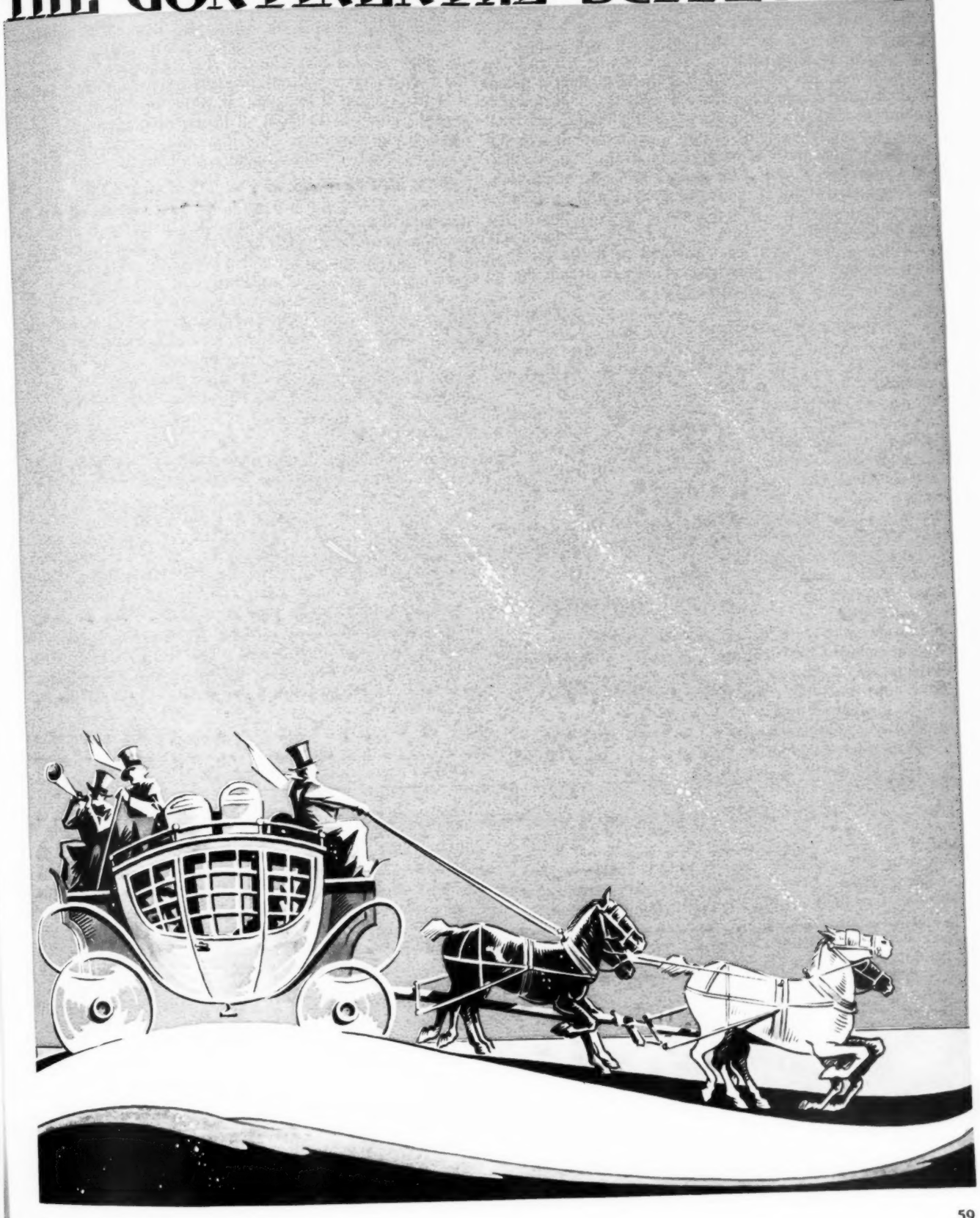
The next most prominent feature attracting the attention of the visitor is the large Ethyl fluid storage tank, occupying almost half the room, partially below floor level, and resplendent in shining aluminum paint. This tank is of heavy steel seamless construction and has two outlets at the top of the tank. The tank rests on steel I-beams comprising a scale linkage, contained in what might be termed the weigh pit and connected with what on first sight appears to be an ordinary platform scale weigh beam. This scale beam, however, is a very accurate weighing machine developed by the Howe Scale Company and is called a "Howe Weightograph." It is an electrically-operated magnifying device for observing slight movements of the beam and indicates the weight to an observer on an illuminated ground glass screen. Thus, the amount of Ethyl fluid to be used in a mix can be measured by weight and with a high degree of accuracy. This measuring device is so accurate that all windows and doors must be closed, as even a very slight wind pressure on the tank would be recorded.

An electrically-driven, double-acting, piston type pump

* Ethyl Gasoline Corporation.

SEASON'S GREETINGS..

THE CONTINENTAL SUPPLY CO.



occupies one corner of the room, with a bank of control valves, and what appears to be a rather confusing system of piping, gauges and valve wheels. The plant is by no means as complicated as this first casual inspection would appear, but before going into detailed description of the various units and how they operate, the fundamental principles underlying the design and operation should be kept in mind.

Essentially, the mixing installation consists of a tank for storing Ethyl fluid, a means of weighing out, or measuring, the amount of fluid desired to add to a known volume of base stock gasoline, a suitable injector for introducing the fluid into a stream of the gasoline to be treated, a pump for circulating the gasoline from the storage tank through the mixing plant, where it picks up the fluid and is returned to the storage tank, and, finally, a means of thoroughly mixing until the finished product is uniform. Notice that in the operation of the older drum mixing installations a definite amount of Ethyl fluid was used—that is, a definite number of drums—and that the amount of gasoline to be treated with Ethyl had to be measured out, the exact amount depending on the Ethyl content required in the finished Ethyl gasoline. But in this new, up-to-date installation a definite amount of base stock gasoline, contained in one of the storage tanks, is used, and the amount of Ethyl fluid required is measured out. Needless to say, it is far easier to measure the fluid by weighing it than it is to measure the gasoline, and this marks another advantage of the tank car installation.

To describe the actual construction and operation of the plant as outlined above, it is convenient to think of the installation as composed of seven units, although it is really one complete, efficient unit for treating gasoline with Ethyl brand of anti-knock compound and making it into Ethyl gasoline.

These seven parts, which should receive our consideration in understanding the construction and operation of the plant, are listed in order as follows:

1. A storage tank for Ethyl fluid.
2. A weighing system for measuring the amount of fluid to be used.
3. An eductor, or injector, and its piping system for introducing Ethyl fluid into the gasoline being treated.
4. A pump for circulating gasoline through the eductor.
5. A means of adding the required additional amount of dye to the gasoline.
6. A circulating system for perfecting the mixture.
7. Arrangements for transferring Ethyl fluid from the tank car to the storage tank.

The storage tank and weighing equipment have already been described. As the tank rests on a scale mechanism, it obviously cannot be rigidly connected with the system, connections being made by specially-made metal flexible connections which are developed to give a flexible but leak-proof connection. These flexible connections are used on both outlets to the tank. The outlet at the extreme end of the tank is connected to piping through which fluid is removed from the tank and through the mixing system. This outlet takes fluid from the bottom of the tank through a pipe extending down through the tank to the bottom; and in order that the tank may be completely emptied it has a shallow well, or depression, so that even a very small amount of fluid remaining may be withdrawn. The other outlet to the tank is connected so as to provide a means for evacuating the tank—that is, keeping it under reduced air pressure. It is also connected so that the tank may be vented to the roof.

The essential feature of the whole installation is the eductor. This device is similar to the familiar steam injector. For example, it comprises a venturi tube placed in a gasoline circulating line, a third outlet being provided at the point of constriction of the venturi tube. As gasoline flows through this eductor a suction or a vacuum is set up in the line connected with the third outlet. This is the unique feature of the whole installation. The entire plant is operated on the pressure differences set up by the eductor. The motor-driven, piston type pump functions solely in circulating base stock gasoline from the storage tank being treated with Ethyl fluid, through the eductor and back to the storage tank. Therefore, it might be said that the gasoline being blended supplies the power operating the blending plant. The eductor acts as a pump evacuating the system and as an aspirator, the Ethyl fluid being sucked into the stream of gasoline flowing through the eductor. By this means it is dissolved in part of the gasoline being blended and transferred into the storage tank, where it is further mixed with the remainder of the base stock gasoline.

Ethyl fluid itself carries a certain amount of the red dye for coloring the finished product. The amount of dye in the fluid, however, is such that it will bring the finished gasoline up to the Ethyl Gasoline Corporation's color standard if the maximum treatment of three cubic centimeters per gallon is used. As practically all base stock gasolines treated with Ethyl fluid do not require the maximum treatment, it is obvious that a certain amount of additional coloring matter or dye must be added, in addition to that in the fluid, in order to bring the finished gasoline up to the Ethyl Gasoline Corporation's color standard. Equipment for accomplishing this varies in different installations and an efficient way is that used in the Great Lakes Pipe Line Company plant.

In the first place, the dye must not be mixed in the Ethyl blending room. The whole installation has been designed with the object of handling Ethyl fluid with extreme care and avoiding leaks or spills, and the personnel is trained to associate any red color which may appear in the Ethyl room as Ethyl fluid, calling for immediate correction. So in order to inspect the equipment for adding dye a visitor would have to go outside the building. Here he will find a vertical cylinder with pipe connections. The necessary amount of dye, in the form of a dry powder, is weighed out and placed in the dye pot. The dye pot is connected with the gasoline circulating system so that gasoline may be circulated through the dye pot, dissolving the dye during this process.

While outside the building it might be well to describe the equipment provided for unloading a tank car of Ethyl fluid and transferring it to the Ethyl fluid storage tank. Here, instead of a usual unloading line, such as is used at a bulk station in unloading a car of gasoline, there is a double pipe arrangement, two pipes protruding from the wall on swing joints, joined together at the outer end with the necessary shut-off valves. The lower line is the fluid line, through which Ethyl fluid flows from the car to the Ethyl fluid storage tank inside the building. The upper line is a gasoline line, so that after the car is emptied, gasoline may be run into the car for washing it out, this gasoline then being sucked out and pumped back to an Ethyl Gasoline storage tank. He will also note that the tank car is not vented to the air, but that the tank car vent is connected by a flexible hose to the lower line, which is a suction line. Thus, when washing out the fluid car, gasoline can be run into the car with no release of gasoline or Ethyl fluid vapors to the air.

One more piece of apparatus is necessary to complete a description of the Ethyl plant, although properly it is not a part of the plant at all and is not located in the Ethyl room. As previously mentioned, a large centrifugal pump is provided for circulation to and from the Ethyl Gasoline

tank, after the mix is made, turning over the batch in the tank until a perfect and uniform mixture is obtained.

Before describing the operation of the plant and how a mix is made, a few observations are in order. Returning to the Ethyl blending room, it should be noted that all piping, valves and fittings are of the heavy "ammonia" type and that they are in perfect order, having been inspected and tightened since the last mix.

A set of tools, flange wrenches, etc., are in readiness for emergency use and a large drum of kerosene and two buckets are handy for use in washing down a leak or fluid spill, together with a sufficient length of water hose to reach all parts of the building for complete flushing.

On the wall are two neatly-framed charts; one is the Ethyl Gasoline Corporation's "Rules and Regulations Governing the Handling of Ethyl Fluid," the other is the "Mixing Chart," giving the necessary data as to the amounts of fluid and additional dye to be used in making the mix with the desired amount of base stock gasoline.

To one side is a separate shower and locker room for the operators. Each man has two lockers—one for his ordinary apparel and one for his white working clothes, shoes, gloves and gas mask. While a change of clothing is not necessary for making a mix, it is necessary when unloading a car of fluid or in case fluid escapes through a leak or other accident. On these occasions the Ethyl Gasoline Corporation's regulations calling for a complete change of clothing, all white, to make conspicuous any contact with the red fluid, must be adhered to strictly and followed by a thorough bath when the operator is through working.

Now observe this Ethyl blending plant in operation. A tank car of Ethyl fluid is received and is spotted on the track ready for unloading. The operator and his assistant have donned their working uniforms, have their gas masks in readiness in event the car shows evidence of a leak, and the dome on the car is ready to be opened. The car dome is locked and the only key is in the possession of the plant superintendent, who thus is directly in charge of the operation of the plant. The unloading line is then connected to the fluid outlet on the car by means of a rigid flanged fitting, a new gasket being used each time.

The gasoline reciprocating pump is then started, forcing gasoline through the eductor, and the proper valves opened, connecting the storage tank to the suction side of the eductor. This serves to evacuate the tank. The fluid valve and vent valves on the car are then opened and the proper valves on the unloading line are opened so that the fluid flows from the car into the storage tank, both by the action of reduced air pressure in the tank and also after starting by a siphoning action. Progress of the unloading process can be watched by observing the weightograph. When no further increase in weight is observed and the net weight corresponds with the weight shipped, the storage tank outlets are closed. It is then necessary to wash out the car. This is accomplished by running part of the circulating gasoline through the upper pipe of the unloading line into the tank car, venting by means of the flexible hose back into the lower, or fluid line, on which a suction is still maintained by means of the eductor. This gasoline is then evacuated from the car back to the gasoline storage tank and the process repeated several times. The fluid car can then be disconnected.

In making a mix the first step (after the base stock to be blended has been tested in the Ethyl Gasoline Corporation laboratory and the treatment necessary determined in c. c. per gallon) is to consult the "mixing chart" and ascertain the weights of fluid and additional dye required, based on the gallonage to be treated.

The scale beam is then balanced and the weight of fluid desired is calculated. The weightograph indicator will then show the number of pounds to be added. Base stock gasoline is then circulated through the eductor and the fluid injected, or rather, aspirated, into the stream of gasoline flowing through the eductor. It is then only necessary to observe the weightograph indicator and cut off the fluid when the indicator drops to zero.

The necessary amount of dry dye is then weighed out and placed in the dye pot. This is dissolved by the stream of gasoline through the pot, completing the actual mixing operation. It only remains to circulate the storage tank containing the mix until uniform.

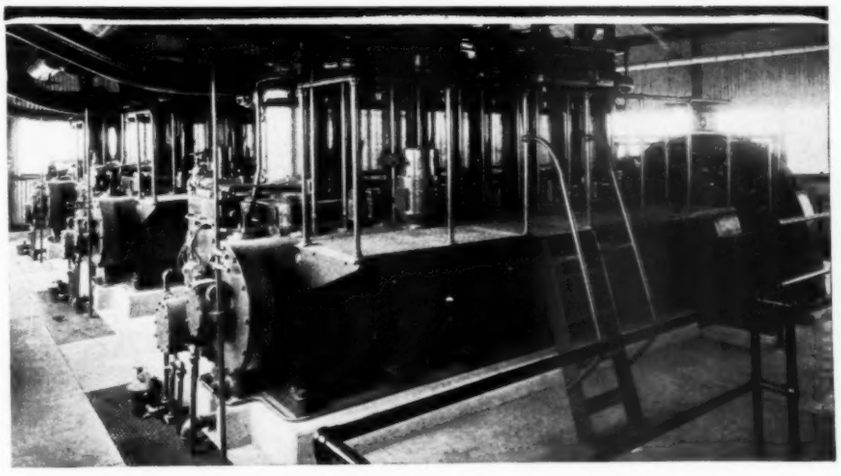
Uniformity of mix is determined by taking samples from top, middle and bottom of the tank, which must test the same on analysis.

The Great Lakes Pipe Line Company also has similar installations located at St. Paul, Minn.; Chicago, Ill.; Des Moines, Iowa, and Omaha, Neb. These plants are of recent design and therefore embody the most improved type of installations now in use. Other tank car mixing installations are essentially the same, but naturally each shows improvements over those built earlier.

Western Gas Company Line Has High Peak Capacity

ONE of the principal reasons for the projection of the 290-mile extension from El Paso, Texas, to Cananea, Mexico, was the large immediate and potential market represented by copper mining and smelting companies. With the line now completed and in operation, the industrial consumers in Douglas and Bisbee (Arizona) and Cananea (Mexico) are assured of a plentiful supply of natural gas from the Lea County fields of southeastern New Mexico.

Flexibility in handling loads was made possible by the erection of two compressor stations on the El Paso Natural Gas Company's 16-inch line, and two stations on Western Gas Company's 12¾-inch extension. The line pipe, of course, has a very high yield point.



Three Cooper-Bessemer units rated 760 b. h. p. at 180 r. p. m. in Western Gas Company compressor station near Fort Bliss, Texas.

PERFECT PERFORMANCE

And Another World's Record!

H. L. BLACKSTOCK
Oklahoma City, Drilling Contractor for the deepest well in United States

This time the American, 3-inch, 5⅝-inch Diameter, Releasing and Circulating Overshot, was used exclusively to pull 10,079 feet of 3½-inch A. P. I. Drill Pipe from the deepest well in the United States. Drilling Contractor H. L. Blackstock for Mid-Kansas Oil and Gas Company, and Ramsey Petroleum Corporation, Caddo County, Oklahoma.

An interesting and difficult feature was the fact that the kelly had twisted off below the swivel sub, which necessitated catching the round part of the kelly, which was less than 10 inches long. When the kelly sub twisted off, the pipe and kelly dropped so that top of fish was about 19 feet below the rotary table. This means that the 149,212 pounds of drill pipe and equipment was caught and pulled when anything short of Perfect Performance might have meant disaster.

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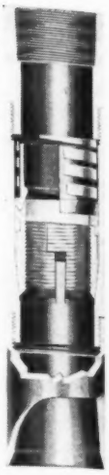


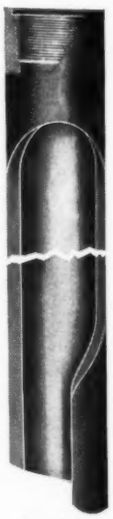
Releasing and Circulating Overshot

THE DRILLING CREWS:
(Left)

Front row, left to right: H. E. McNees, geologist, L. W. Jones, geologist, O. V. Dill, district foreman.

Center row, left to right: (crew on evening tour): J. F. Hughes, sample catcher, Pete Weise, derrick man, B. Goodwin, pipe racker, D. B. Butler, fireman, Y. Boles, driller.

Back row, left to right: (crew on morning tour): Pat Dailey, sample catcher, Jess Collins, Fireman, George Allen, floor man, Albert Beveridge, pipe racker, J. D. Bailey, derrick man, W. M. "Bill" Bailey, driller.



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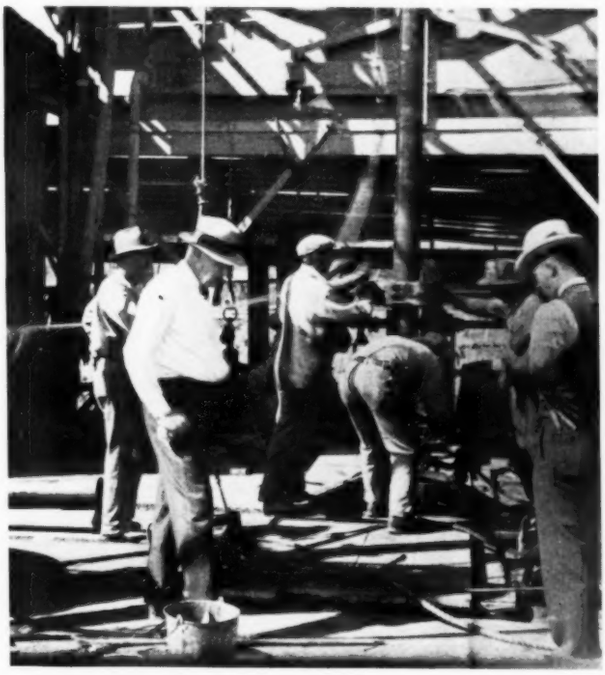
MANUFACTURERS OF OIL FIELD EQUIPMENT

Deep Test Proves Equipment Entirely Adequate

THE deepest test ever drilled in the United States, the Mid-Kansas Oil & Gas Company and Ramsey Petroleum Corporation's Preston-Culp No. 6, near Cement, Oklahoma, will not be drilled deeper. Thus, one of the most interesting drilling operations ever conducted will be brought to a close. However, it will undoubtedly be looked back upon as marking the entrance of a new drilling era—a period of time that will see holes drilled to 10,000 feet and below with ease and regularity.

Speaking from an engineering and equipment standpoint, no test in the United States has been as interesting as the Preston-Culp well. When drilling was commenced on this well on January 4th it was not the intention to establish a new drilling depth record, but lack of plans did not prove detrimental and the modern equipment, handled with skill and care, proved equal to drilling an 8⅛-inch hole to 10,079½ feet, a depth reached early in October. The ability of heavy, rotary equipment to drill to this depth without particular preparation in boring the upper portion of the hole (which would have aided tremendously in the lower part of the hole) demonstrates conclusively that equipment of today can drill much deeper holes. Nine-inch casing was set and cemented at 5,515 feet and drilling was conducted through this casing string. This constitutes a remarkable drilling performance as more than 4,500 feet of hole was made without setting another casing string. After reaching 10,079½ feet a string of six-inch casing was set at 9,777 feet.



Scene showing casing operations on cement well.

The latter string of casing is the longest ever set, and the ease with which it was lowered into the hole illustrates that longer strings of pipe can easily be landed. Trouble was experienced, however, in gaining circulation prior to cementing, due probably to the small space between the pipe and side walls of the hole, a factor which can easily be eliminated by making a larger size bore. Probably this will be a practice in all future deep planned tests.

Circulation was finally established by the reverse method, by injecting mud into the annular space between the nine- and six-inch strings by means of a Hercules casinghead installed in the cellar of the well. Cementing was also done in a manner contrary to usual practice, because of inability to establish circulation by regular direction of flow, and also constitutes a remarkable accomplishment. Many factors detrimental to placing cement at the greatest depth it has been poured, proved slightly superior to the reverse flow method used, but showed that with employment of regular cementing methods little difficulty from this angle may be expected. There were only two mishaps to mar the otherwise perfect drilling record of the test. A string of drill pipe parted, leaving slightly less than 10,000 feet of drill pipe in the hole. This was no reflection on the pipe, however, as it had been used to drill several wells, and parted at a depth far below that recommended by the manufacturers. However, an American Iron & Machine Works Company four-inch, 7½ O. D. releasing and circulating overshot within a few hours lifted the tremendous weight of 171,936 pounds of four-inch drill pipe to the derrick floor and established another record for heavy weight fishing. A second twist-off occurred, also while the well was at 10,079 feet, when the kelly twisted off below the swivel sub, the pipe and kelly dropped 19 feet below the rotary table. A 3-inch American, 5⅝-inch diameter, releasing and circulating overshot, lifted 149,212 pounds of 3½-inch drill pipe to the surface. The only other difficulty encountered in drilling was in penetrating some exceedingly hard formations.

The equipment used on the well was regulation, heavy duty, rotary type, practically all of which had been used previously in the Oklahoma City field. The fact that none of it was of special design and had previously seen duty in the oil fields establishes beyond a doubt the adequateness of modern equipment.

Among the records that stand out as worthy drilling feats established in drilling this test are: (1) penetration to a greater depth than any other test in the United States and second only to one other well which was drilled in Mexico; (2) landing of the longest string of casing; and (3) successful fishing of the heaviest string of drill pipe in the world. These records are all enhanced when it is remembered the test was not started with the intention of going to 10,000 feet. Before long it is likely that other tests will drill deeper and set longer strings of pipe, as present day drilling limits are in excess of these marks for any test that is commenced at the surface with prepared plans for going below 10,000 feet. Additional data on this well may be secured by referring to the September, 1931, and November, 1931, issues of The Petroleum Engineer.

The Preston-Culp well is now being plugged back to determine if any of the upper showings are of commercial value and it is possible that the well may be completed as a deep producer as several of the showings found are believed to have had considerable gas pressure. The heavy string of six-inch casing will be ripped by discharging large explosives shots at the desired points.

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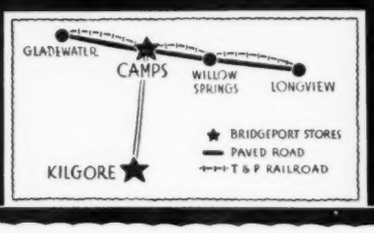

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The Construction of

Nomographic Charts

By H. V. BECK[1]

DURING the past few years there has been a growing tendency to use nomograms, or alignment charts, as they are sometimes called, for the solution of engineering formulæ. Because of this growing tendency and in order to facilitate the work of the engineer, it is to his advantage to know something of the construction and use of these relatively simple charts.

The type of charts that will be discussed in this article are those composed of parallel logarithmic scales, used for multiplication and division of factors raised to various powers. The result of the multiplication or division, as the case may be, is indicated on the result scale by its intersection with a straight line connecting the factors involved. A monogram will be constructed to fit the typical formula, $A = 2.5\frac{B^2\sqrt{C}}{D}$. This formula was chosen because it contains all the different types of factors that are discussed, namely: 1, Factors raised to powers greater than unity; 2, factors under the radical sign or those raised to powers less than unity; 3, factors that appear in the denominator; and 4, constant multipliers.

It might be wise to discuss the limitations of this type of chart before proceeding with its construction. Since we use our eye as a means of locating the factors on their respective scales, it is obvious that the chart of ordinary size can be accurate only to two or three significant figures. It cannot be used, therefore, for the solution of formulæ in which a greater degree of accuracy is required. The degree of accuracy of the chart may be increased by increasing the size of the chart and in exercising care in its construction. It should also be remembered that many solutions of the formula can be made in the time required to construct the chart and hence the use of this method is not justified except in those cases when it is necessary to perform a large number of calculations involving the relation.

The objection of the limited accuracy of the chart is fortunately not a serious one, since in most cases engineering data are not accurate to a greater degree than that of a well-constructed chart. For example, it is a rare occasion when gauge pressures and temperatures are read accurately beyond the second or third significant figure. Greater degree of accuracy in the result than in the data upon which the computation is based is unjustified and entirely fictitious.

With these limitations in mind, let us proceed with the construction of the nomogram for the typical formula: $A = 2.5\frac{B^2\sqrt{C}}{D}$. It is first necessary to construct a logarithmic scale chart of the form shown in Figure 1. This chart facilitates the choice of logarithmic scales of various lengths or moduli. The modulus of a logarithmic scale is a figure representing the length of that scale—that is, a scale with a modulus of 5.0 is 5.0 units in length. In following this discussion the similarity between the slide rule and the nomographic chart will become evident; both operate on the principle of addition and subtraction of logarithms.

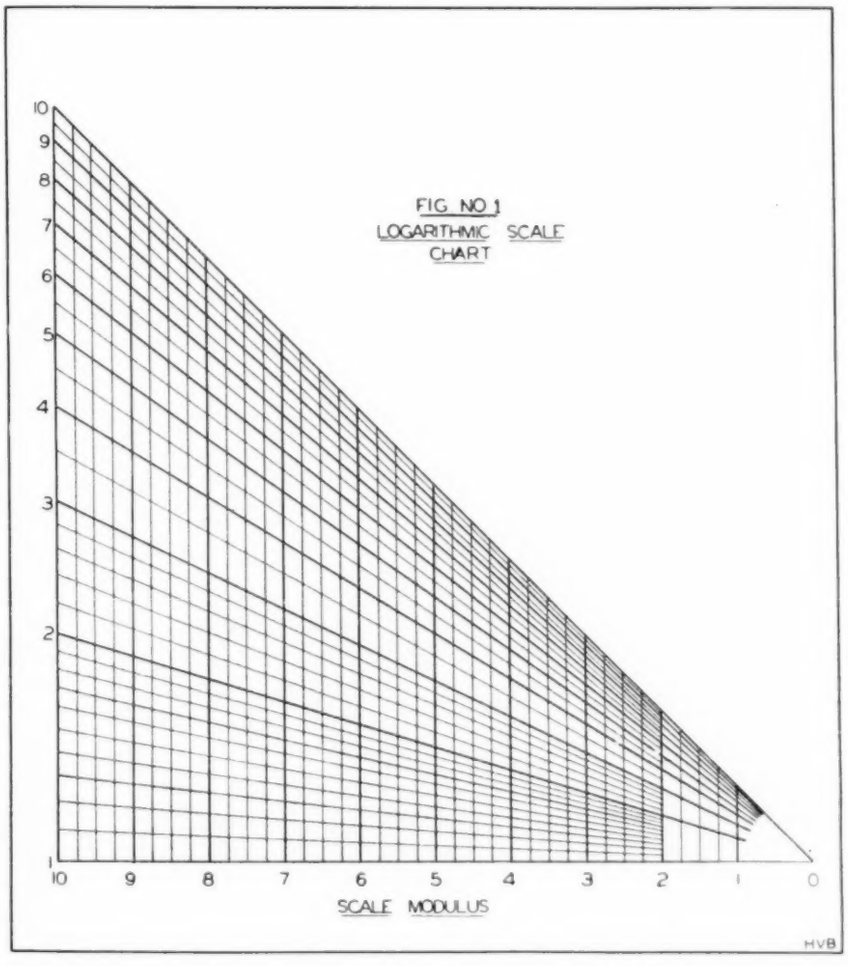


FIG. NO. 1
LOGARITHMIC SCALE CHART

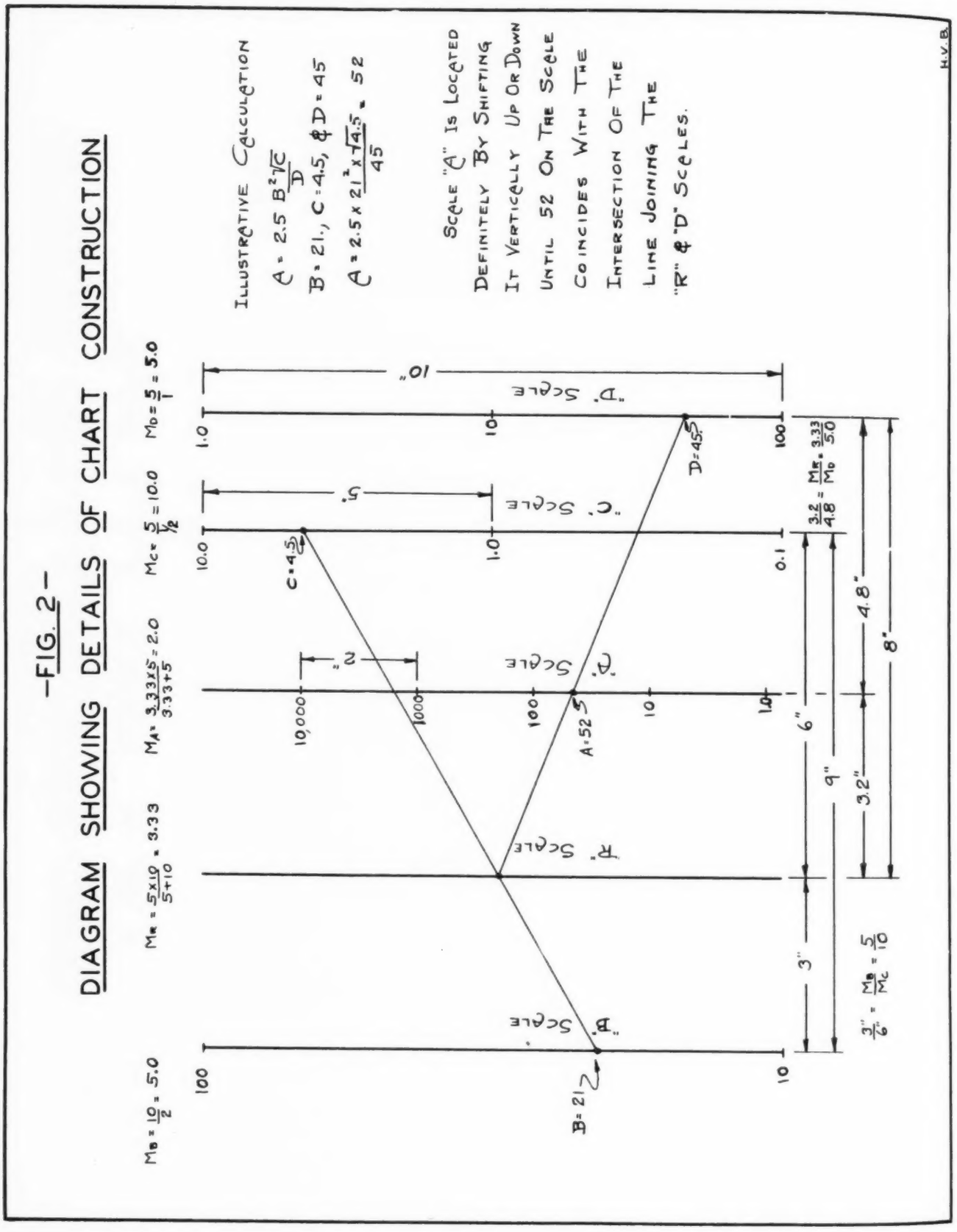
Scales are laid out with such a modulus that the length of scale for the required range is that desired. For this reason the limits of variation of the factors involved should be known.

When a factor is raised to a power, the length of the scale, or apparent modulus, as we shall call it, is the

[1] Assistant Professor of Mechanical Engineering, University of Oklahoma.

product of the power and the actual modulus. The reason for this is that the logarithm of the factor raised to a power is equal to the product of the power and the logarithm of the factor. As an example, the "B" scale varied from 10 to 100. In order that the scale occupy a moderate length, say 10 inches, the apparent modulus or length of scale is fixed at 10. Since this apparent modulus is the product of the power and actual modulus, it is evident that the actual modulus for this scale is 10 ÷ 2, or 5.

Scale "C" was laid out in a similar manner. This factor



is under the square root sign or is raised to the equivalent power of one-half; $\sqrt{C} = C^{1/2}$. The range of this scale is from 0.1 to 10.0 (two scale lengths), with an apparent modulus of 5.0. The actual scale modulus, following the same line of reasoning as that outlined above, is of course $5 \div \frac{1}{2}$, or 10.

The result of the multiplication of factors "B" and "C" is read on the result scale, designated scale "R." This scale is not graduated, for we are not primarily interested in the product $B^2\sqrt{C}$, but in the result of the solution of the entire formula. For this reason only the relative point of intersection of this scale is necessary. The spacing of a result scale is in the ratio of the actual moduli. Consequently scale "R" is located twice as far from the "C" scale as from the "B" scale, or in the ratio $\frac{Mc}{MB} = \frac{10}{5}$. The actual modulus of the result scale is determined by the relation $MR = \frac{M_1 \times M_2}{M_1 + M_2}$ where M_1 and M_2 are the actual moduli of the scales involved. In this case the actual modulus of scale R is $MR = \frac{MB \times Mc}{MB + Mc} = \frac{5 \times 10}{5 + 10} = 3.33$. This modulus is necessary for the proper spacing of the final result scale, scale "A," the describing values of which will be determined in a similar manner.

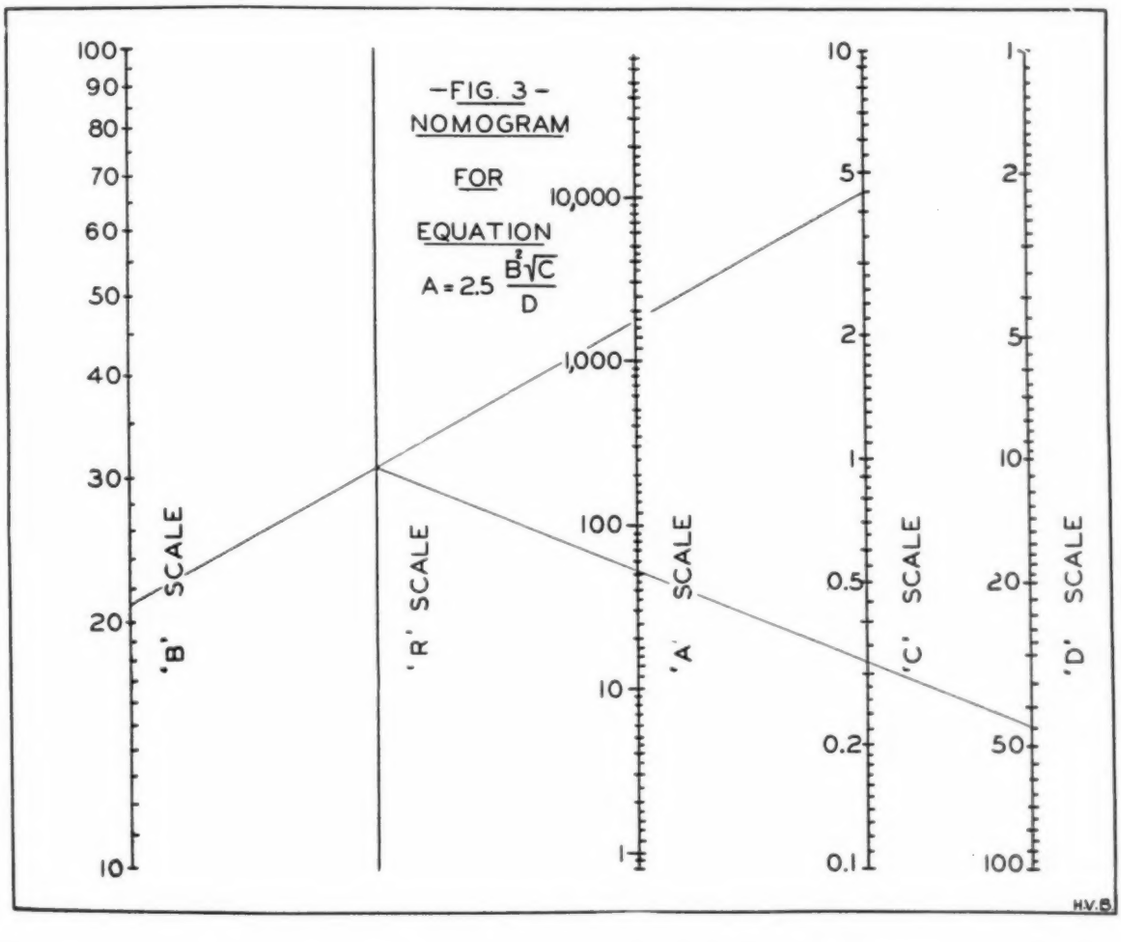
The factor "D" appears in the denominator and the division, or subtraction of logarithms, is accomplished by running this scale in a direction opposite to that of scales representing factors in the numerator. Since this factor is raised to the first power its actual and apparent modulus are equal, which for a range of 1.0 to 100 (two scale lengths) is 5.0.

The position of the "A" scale relative to scales "R" and "D" is in a ratio of their respective actual moduli, 3.33 and 5.0. The actual and apparent moduli of scale "A," since "A" is raised to the first power, are equal and which value, determined by the before-mentioned relation, is $\frac{3.33 \times 5.0}{3.33 + 5.0} = 2.0$.

The effect of varying the constant multiplier, which in this case is 2.5, is either to raise or lower the final scale. Therefore, to fix this scale for the position corresponding to the value of 2.5, it will be necessary to assign a set of values for the variables and shift scale "A" until it fits this particular determination. Then, if the chart has been correctly and accurately constructed, it will check on all other values within the range of the chart.

In this article the author has not attempted to show the mathematical derivation of the relations expressed nor to cover completely the field of nomography. To do so would be completely beyond the scope of a single article. It has been his purpose, rather, to explain and demonstrate in as clear a manner as possible the construction of a simple and typical nomogram.

The author welcomes any queries, suggestions, or criticisms covering any of the material included in this article.



Automatic Gas Heaters Used at Some Electrical Dehydration Plants

WITH most emulsions heating is desirable to raise the efficiency of the treating process. This naturally must be accomplished in an economical manner and the use of gas heaters in some recent installations in California has indicated one satisfactory method of cutting down fuel costs.

While the application of heat to the wet oil is not an actual function of the electrical process of treating emulsions, it is generally a means of increasing the capacity of the plant and, therefore, of cutting down the installation and operating costs. Heat lowers the viscosity and accelerates the settling out of the water after the emulsion has been broken; and in this way it speeds up the flow of fluid through the dehydrator. Some oils, of course, settle rapidly at their production temperatures and do not need additional heat to speed up the operation. It has been found, however, that a temperature of about 130 degrees F. is desirable in the average electrical dehydration installation, with the character of the oil and tightness of the emulsion having considerable influence on the specific temperature to be used.

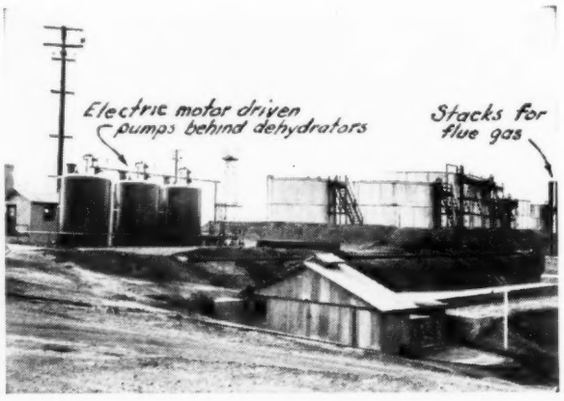


Fig. 1—In the lower foreground is a permanent automatic gas heater which preheats the wet oil before it enters the electric dehydrators shown on the left.

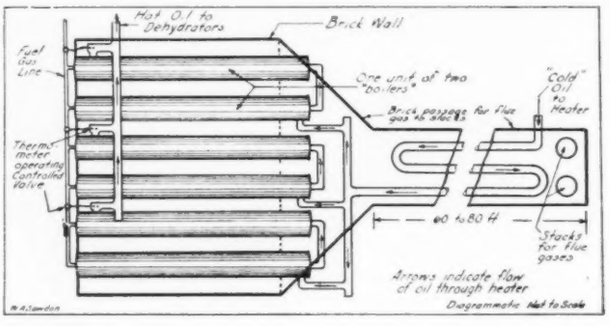

Hot Oil to Dehydrators
Brick Wall
Fuel Gas Line
One unit of two "boilers"
"Cold" Oil to Heater
Brick passage for flue gas to stack
Thermometer operating Controlled Valve
60 to 80 ft
Stacks for flue gases
Arrows indicate flow of oil through heater
Diagrammatic Not to Scale

Fig. 2—The permanent automatic gas heater takes advantage of all the heat possible. This indicates the approximate construction of the installation in the Culver City field, California.

Severe cutting sometimes accompanies gas lift operations and in the Long Beach, Calif., field, where much of the oil is so produced, many of the emulsions have to be heated to as high as 190 degrees F. There have also been instances where the cut oil has been raised to a point just below boiling. These factors must be considered when designing a plant totally powered by electricity and due consideration should be taken for providing an economical method of heating when steam is not readily available.

Since there is no necessity for using very high temperatures for any of the oils treated by electrical dehydration, the problem of preheating the oil is comparatively simple. One of the advantages of the electrical process is the prevention of loss of gravity and light oil fractions by the closed system and the cooling of the treated oil to a normal temperature by heat exchangers or cooling towers before it enters the stock tank or storage. Yet the required temperature must be maintained to make available the desired capacity of the dehydrators, no matter how little above the production temperature this may be.

Two variations of one type of gas heater are being used in some of the California fields. One of these is a permanent installation and is shown in Figure 1 with a diagrammatic plan given in Figure 2. This particular installation is located in the Culver City field just outside of Los Angeles and is handling a relatively loose emulsion.

The heating system contains three units, each of which consists of two cylindrical containers about 30 inches in diameter by 20 feet in length. These cylinders, which can best be designated as "boilers," contain a number of tubes through which the oil passes from the inlet to the outlet. The space around the tubes is filled to about three-quarters of its depth with water and this water maintains an even temperature which is imparted to the oil. These boilers are set in brick with individual fire boxes under each.

The wet oil from the well enters the heat exchangers where it takes some of the heat from the treated oil passing from the dehydrators to the tanks. It is then piped three times through the long flue chamber shown in the illustrations and absorbs more heat from the flue gas before the burned gas passes into the air through the stacks. Entering the manifold, the fluid is then diverted to the first boiler of one of the units, is further heated during its progress through it and then goes on to the second boiler. It there reaches its designated heat and passes on to the dehydrator.

The temperature of the oil as it leaves the heater is automatically controlled. A thermometer placed in the oil discharge line actuates a controlled valve on the fuel gas line. As the temperature tends to exceed that for which it is set, the valve closes and decreases the fuel supply into the two fire boxes of the unit. As the temperature falls, the valve is opened and more gas is allowed to pass through the line.

An attempt was first made to regulate the temperature of all three units by means of one control. To do this, the thermometer was placed on the line after the heated oil from the three units had flowed together in the one main line to the dehydrators. This did not work satisfactorily

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so a control was placed on the outlet from each unit and the gas supply to each is now regulated separately.

By this method an even temperature has been obtained. This also appears to be advantageous since it is felt by those in charge of the operations that the dehydrators have worked better than when the heating was done with steam. The temperature maintained in this particular installation is 160 degrees F.

Each heating unit is rated for 1500 barrels of oil per day. This is also the approximate capacity of each of the three dehydrators, but twice that amount has been put through at various times. When the units were so overloaded, however, the temperature had to be cut down since the desired 160 degrees could not be maintained with the faster flow of oil through the plant.

The pumps are chain connected to electric motors. One is used for circulating the oil through the treating system and is a 3¾x4 driven by a 3-h.p. synchronous motor. This is probably too small for the duty it has to perform. There are two line pumps—a 3½x10 and a 4x10—each driven by a 7½-h.p. variable speed motor.

In the Dominguez Field, California, there is an automatic heater installation that consists of three portable units. The heaters are here set up in a corrugated iron house with concrete floor; but due to their portability these units can readily be moved away and set up at another location should it be desirable. The dehydrators themselves are frequently moved from one lease or field to another and the portable heater lends itself admirably to meeting changing production conditions which necessitate the increase or decrease of treating capacity.

Fig. 3—One of the most widely used types of heat exchangers is here shown. Seal Beach Field, California.

The portable automatic gas heater is mounted on steel I-beam skids which facilitate its loading and unloading on or off a truck. A fire-brick combustion chamber is built on a steel framework which is constructed on the skids and extends to about the middle of a lower boiler. Above this, and arching over an upper boiler, is an asbestos walled chamber. The lower boiler is supported by the steel frame and in turn supports the upper boiler by means of two vertical pieces of pipe. Both ends of these supports were welded when the units were built, but the unequal expansion caused them to crack. A saddle was then made on the top of each support to allow for any sliding action which might occur.

The upper boiler is 24 inches in diameter and the lower one is 30 inches. At each end is a full diameter space filled with oil, and extending between these spaces are small diameter tubes through which the oil flows from the inlet end to the outlet end. Water is kept around the tubes for about three-quarters of the depth of the boiler.

After receiving an initial warmth from the heat exchangers, the wet oil enters the front end of the upper boiler. From there it passes through the tubes to the rear and down into the back end of the lower boiler. It next passes through the tubes in this boiler and reaches its designated heat. It then passes out at the front end of the lower boiler and enters the main line to the dehydrators.

Automatic control is obtained in the same way as described above for the permanent heaters. Each unit has its own thermometer and controlled valve which regulates the flow of fuel gas into the fire box.

The temperature of the oil is here kept at from 170 to 180 degrees F. since it is a very tight emulsion and settles slowly after being broken. When little production is passing through the plant, the temperature is kept down to about 170 degrees as the water seems to settle out rapidly enough at that temperature. The capacity of each of the portable units is rated at 1,000 barrels per day.

Circulation through the plant is readily done with 2-4x6 pumps driven by 5-h.p. synchronous motors. The line pumps provided at this station consist of 3-4½x10 pumps driven by 10-h.p. variable speed motors. The pumping capacity is adequate for the production to be handled.

The heat exchangers at an electrical dehydration plant are important pieces of equipment unless cooling towers are used or unless the oil does not need heating. When properly designed, the heat exchangers have been found to lower the temperature of the treated oil sufficiently to prevent loss of gravity and volume. In this way they insure the advantage of the electrical dehydration system in maintaining the highest gravity of the oil with its maximum volume. This is especially important when oil is purchased on a gravity basis since a loss of less than a point in gravity may establish a lower price.

The use of a gas heater of the type here described or of some other type may greatly facilitate the use of electrical dehydrators. The portable unit can often be installed where only one dehydrator is necessary and where fuel gas is an important item or where the maintenance of a steam plant for the one purpose of heating the oil and driving the treating plant circulating pump is not economical. Local conditions will have to determine the advisability of using a gas heater with electric motor driven pumps. The conditions may also change, and in such an event, the installation of a gas heater and motors can be made with little difficulty.

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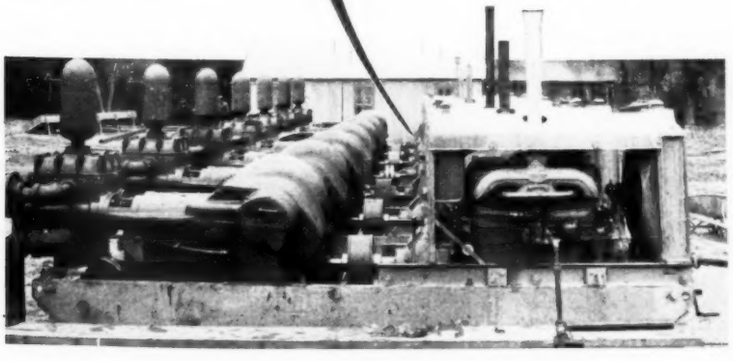

Seven Gaso Fig. 2010-S units serving Lange Oil Company, as water station, Seminole Field, Oklahoma.

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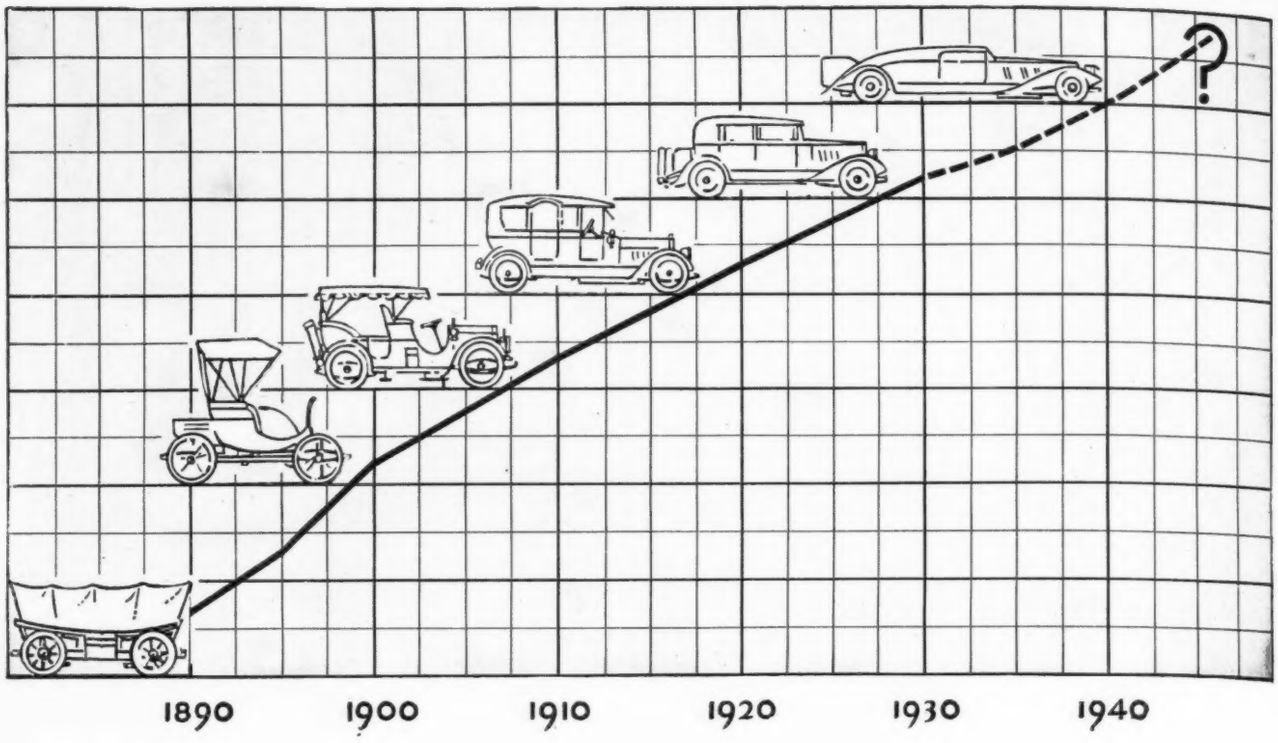

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Look at the record of the past few years. The graph at the right shows the trends of engine power, speed, displacement, brake mean effective pressures and power per cubic inch of displacement, for American passenger cars listed in trade publications. It shows the percentage of increase in these factors from 1925. Where are we going? Where are YOU going? Where this graph is going may help answer your question.

The steady, sharp ascent of the curve of maximum horsepower illustrates the change in engine performance that has been taking place and indicates that future engines will be even more powerful. That this greater power must serve to provide actual car performance improvements and not merely to propel larger and heavier vehicles is shown by the relatively small change in engine size and the marked increase in actual power *per cubic inch of displacement.*

If engine power is to be increased for the most part by some means other than increased size, higher speeds and higher working pressures seem to be the two alternatives. The graph shows they have been accomplishing such improvements in performance in the past.

Various refinements in balancing and design will permit speeds still greater than those now in use. Increased compression ratios will provide higher work-

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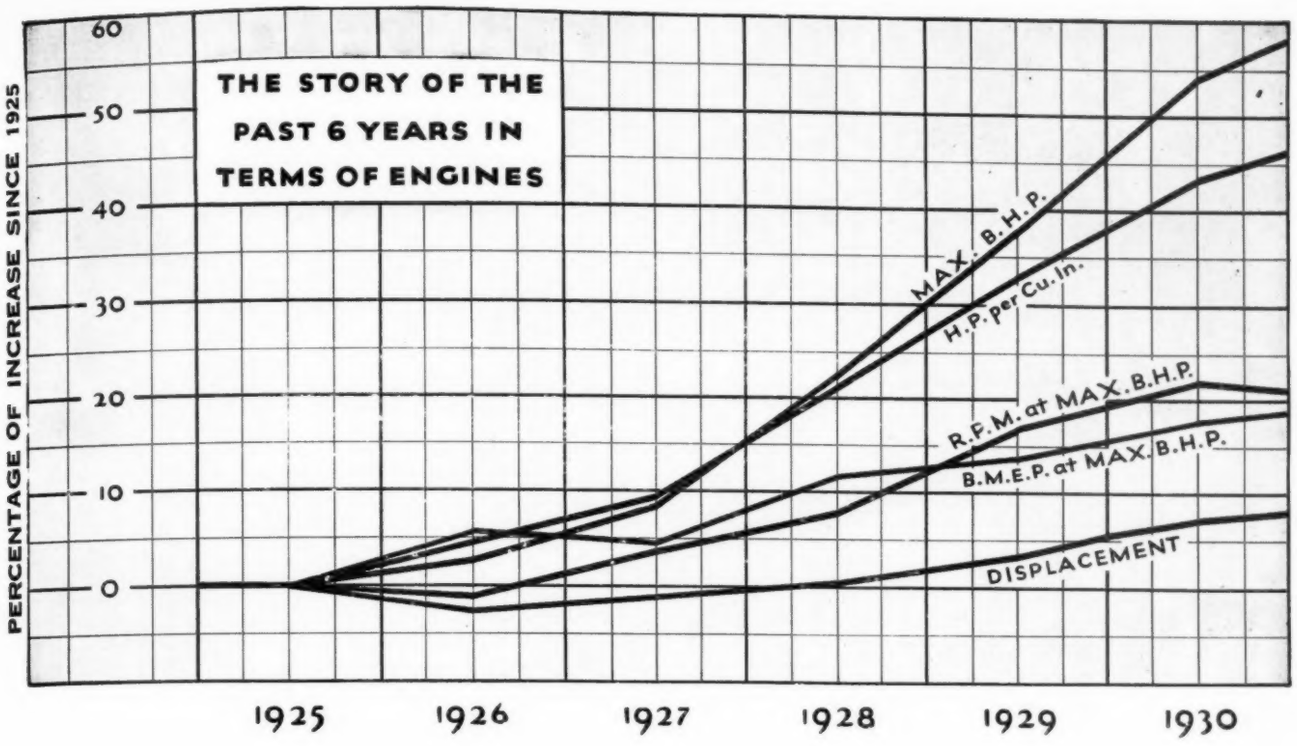

ing pressures with resultant increases in both power and economy. Also higher compression ratios require no changes in engine design other than a slight decrease in clearance volume. The only accompanying requisite is that such an engine must use a fuel of high enough antiknock value to assure proper combustion at the increased pressures.

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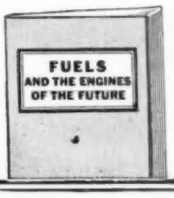
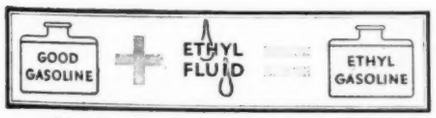
The fifteen charts that summarize the facts in this paper point clearly the present-day trend in engine design in each of the factors relating to the annually increasing compression pressure. You may find them helpful in your thinking toward tomorrow's automobile. It is certain that you will find them stimulating. Mail this coupon now for your free copy.





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GASOLINE

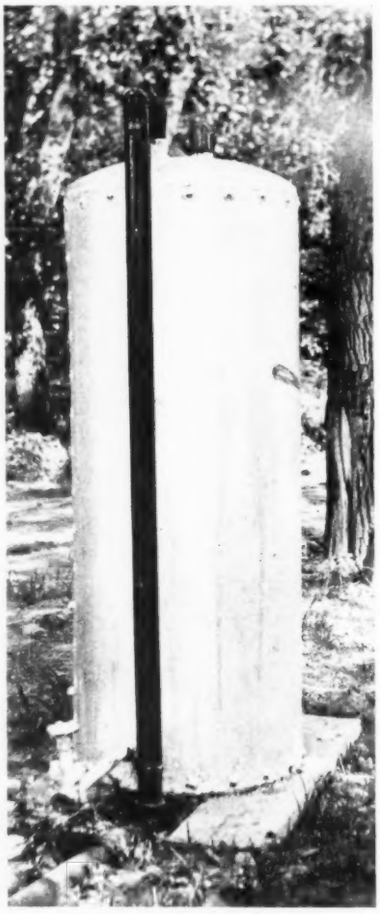
Casinghead
GAS USED FOR PUMPING
Small Leases

PUMPING small producing leases without fuel cost is an ideal condition, but one not always realized. This feat is exactly what Frank Musgrave, field foreman, and F. R. Bartlett, pumper, have achieved for the Gypsy Oil Company on two small leases in the Rainbow Bend, Kansas, pool.

Four wells, all pumping on beams powered by individual gas engines, are operated on casinghead gas produced by the wells. A simple, cleverly-conceived and designed drip and extraction unit takes off the undesired wet gas, leaving the dry gas for running the 25-horsepower, 4-cycle engines.

These wells make a considerable amount of casinghead gas but not enough to operate a gasoline plant, consequently the gas was going into the air before the building of the drip and extraction units. Two of these units are now installed on the properties and give sufficient gas to pump the four wells. One unit is on the J. U. Hunt lease, and the other on the adjoining E. E. Hunt farm, both abutting on the Arkansas River, along the bank of which the wells are located. The J. U. Hunt tract has three wells and the E. E. Hunt lease one.

At the wells where the installations have been constructed, the gas is taken from the Christmas tree and carried by a three-inch line to a buried gas drip. Upon leaving the drip, the gas enters a riser, 12 feet high, made of two-inch pipe. The riser is used to cool the gas, which is then transported by a two-inch line to a small mist extractor.



The gas enters the separator or extractor at the top, and is piped to within 18 inches of the bottom before it is released through two slots in the pipe. The separator outlet is on the side near the top, requiring the gas to rise upward through the extractor to get out. In its course through the separator, the wet mist is extracted from the gas.

The separator is filled to within two feet of the top with machine shop steel cuttings. The larger particles of steel cuttings are placed on the bottom with the finer pieces on top. Four baffle plates are placed within the separator, and are fitted as close around the center inlet pipe as possible so that the gas must go to the outside shell of the extractor to rise. The first of these baffle plates is placed two feet from the top, while the others are one foot apart beneath the first one. The steel cuttings in the separator come up to the top baffle plate.

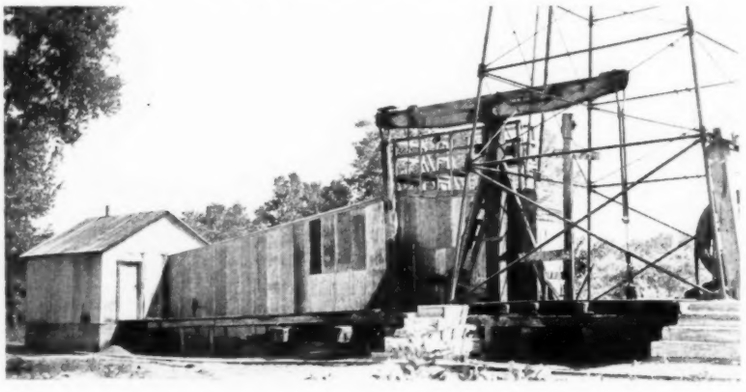
From the separator the gas is carried to a four-inch line that runs the length of the two leases. At all the wells the gas is taken from this four-inch main line to a small scrubber volume tank. The fuel is transported from the scrubber to the engine house by another line. Just outside the house is a gas regulator for governing the pressure of the gas passed to the engine. The gas is carried through the entire process by well pressure.

The installation is equipped with a pit for catching the wet particles taken off at the drip. This pit has a small cistern-type hand pump so that the water may be pumped out.

One of the wells on which the drip and extraction unit is installed makes exceptionally dry gas but the gas from the other well is quite wet. The gas from the dry well is used as much as possible. The unit at the wet gas producer is equipped so that it automatically pops the gas into the air when the fuel is not needed. The dry gas well unit has no pop-off, thereby forcing all its gas into the four-inch line and when pressure is built up to a certain point in the main line, the pop valve in the wet gas well unit functions, permitting its gas to escape. This pop valve is of the ball and seat type installed at the separator outlet line.

Occasionally a slug of wet gas will pass through the units and reach the engine, causing it to run away. This caused

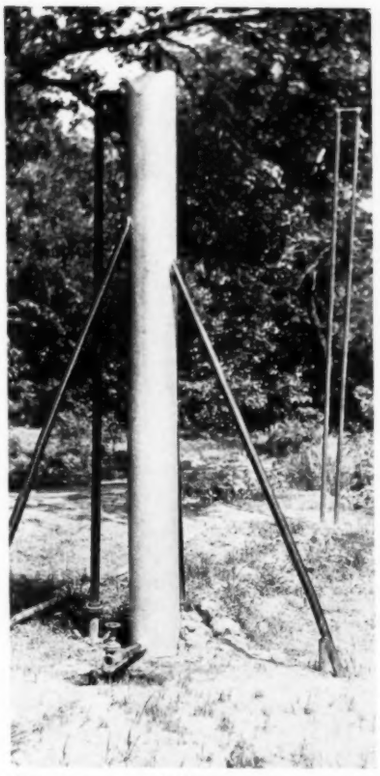
(Above) The gas scrubber. (Below) View of one of the wells where the unit has been installed. Close inspection will show pipe over stirrup end of beam for pumping water well beneath walkway.



the wreckage of one engine, but the trouble has been overcome by a clever idea that rivals any of the famous mechanical cartoons of Rube Goldberg. The upper part of a common tin can has been filled with babbitt, while the lower part is left empty—creating an air chamber and a topheavy can.

The can is set on the head end of the engine cylinder and is connected to the spark plug wire by a piece of heavy twine.

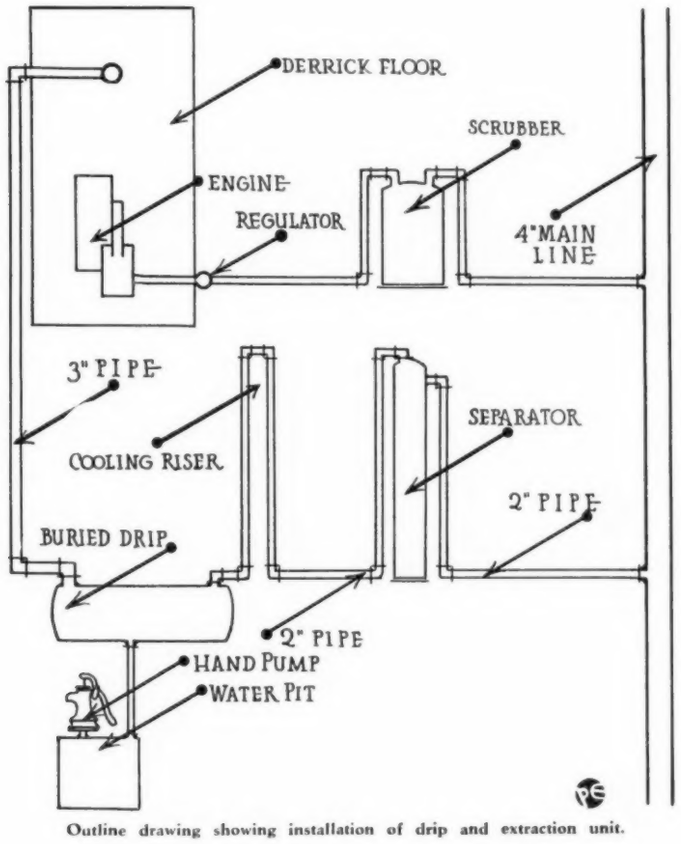
Whenever the speed of the engine accelerates to a degree that excessive vibration is created, the top heaviness of the can causes it to fall off its perch. Since the twine is not long enough for the can to reach the floor, the weight of the can will pull the spark plug wire loose, shutting down the engine before any damage is done by a runaway. Several times the pumper has found the can near the floor and the engine shut down.



The separator in the foreground and cooling riser in background.

Through the use of this extraction and drip unit, fuel for pumping the engines is supplied by the wells.

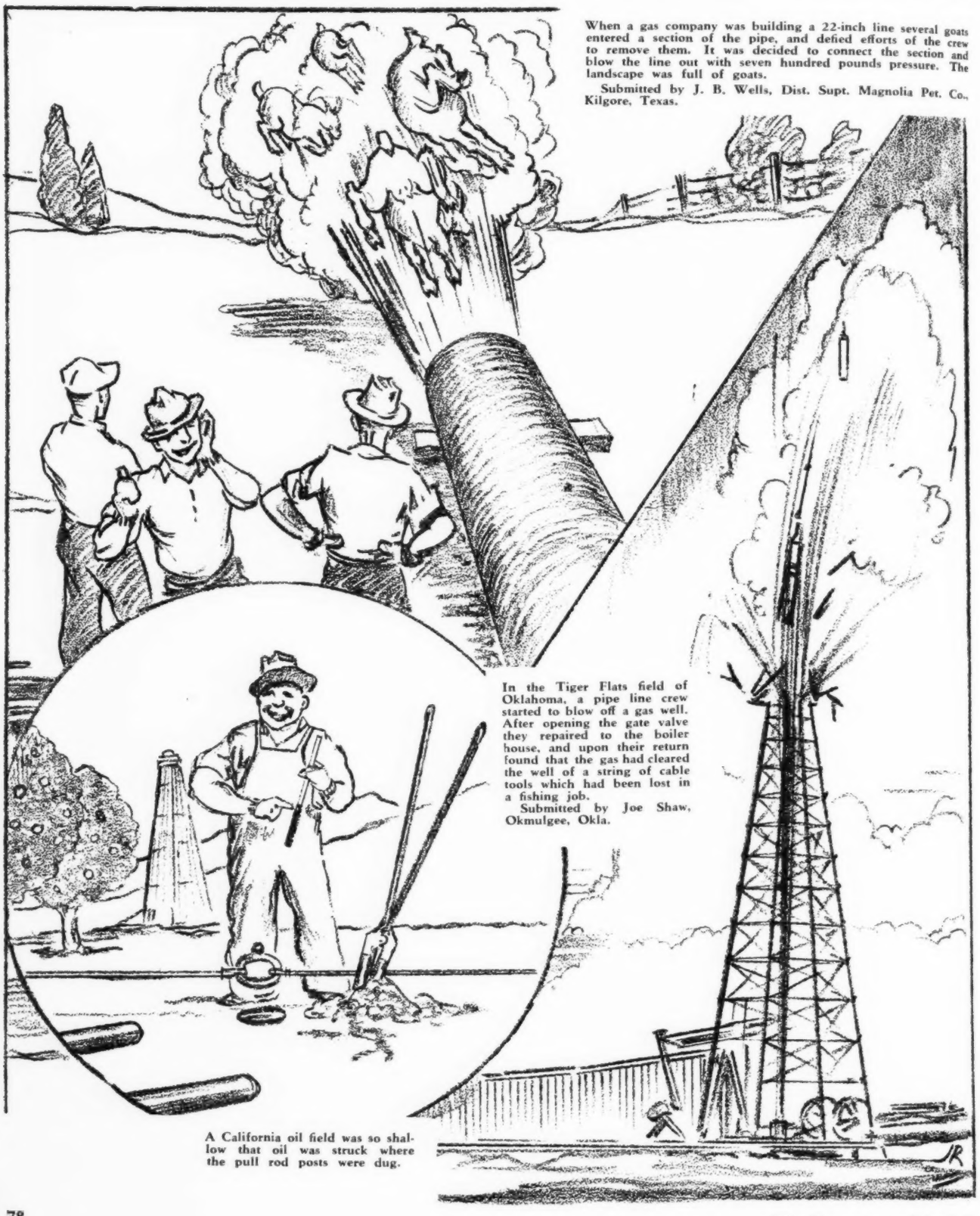
Water for these leases is also supplied without cost. Sufficient water is found from nine to 15 feet below the surface at the wells, as they are so close to the banks of the river. These water wells are located along the walk side of the belt house and are equipped with 2x6 pump barrels, 1¾-inch cups, and 1⅛-inch by 11-foot polish rods. They are operated from the movement of the beams as they pump the oil wells; to provide for this operation a pipe has been lapped over the beam four feet and four inches from its stirrup end. The lower end of this piece of pipe is equipped with a double-threaded sleeve which permits it to be unscrewed or screwed easily onto the polish rods. When sufficient water has been pumped for operating purposes it is only necessary for the pumper to unscrew the sleeve to shut down the water pump.



Outline drawing showing installation of drip and extraction unit.

Strange but True...

HAPPENINGS IN THE PETROLEUM INDUSTRY



When a gas company was building a 22-inch line several goats entered a section of the pipe, and defied efforts of the crew to remove them. It was decided to connect the section and blow the line out with seven hundred pounds pressure. The landscape was full of goats.

Submitted by J. B. Wells, Dist. Supt. Magnolia Pet. Co., Kilgore, Texas.

In the Tiger Flats field of Oklahoma, a pipe line crew started to blow off a gas well. After opening the gate valve they repaired to the boiler house, and upon their return found that the gas had cleared the well of a string of cable tools which had been lost in a fishing job.

Submitted by Joe Shaw, Okmulgee, Okla.

A California oil field was so shallow that oil was struck where the pull rod posts were dug.

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Fishing Jobs *on* Cable Tool Holes Now of Short DURATION

NOT so very long ago it was not uncommon for a difficult fishing job on a well to last for weeks or months. Today, a fishing job, no matter how difficult, rarely extends beyond a few days, thanks to the progress that has been made in drilling methods and improvements in tools and equipment.

How a difficult job was cleaned up in short order on a cable-tool hole recently was recounted by John N. Risher, superintendent in charge of the drilling of the Hilton Phillips wildcat well about six miles northwest of Cushing, Oklahoma. Like the usual wildcat, it offered unforeseen difficulties uncommon to a well in a proven field.

The well was spudded in with a 24-inch hole. One joint of 20-inch, 90-pound casing was set as surface pipe. About 635 feet of 15½-inch, 70-pound casing was set in 18-inch hole, and 1,363 feet of 12½-inch, 50-pound lapweld steel casing was set in 15½-inch hole.

Shortly after the 12½-inch casing was in the hole it collapsed somewhere in the lower end of the string. About 900 feet of the damaged string of casing was pulled and it was found that at about 900 feet the casing had parted. A short joint about 12 feet long had parted completely from the string. This left about 450 feet of 12½-inch casing in the hole with the top at about 900 feet from the surface. Attempts to fish out the short joint that had parted completely from the string were unsuccessful.

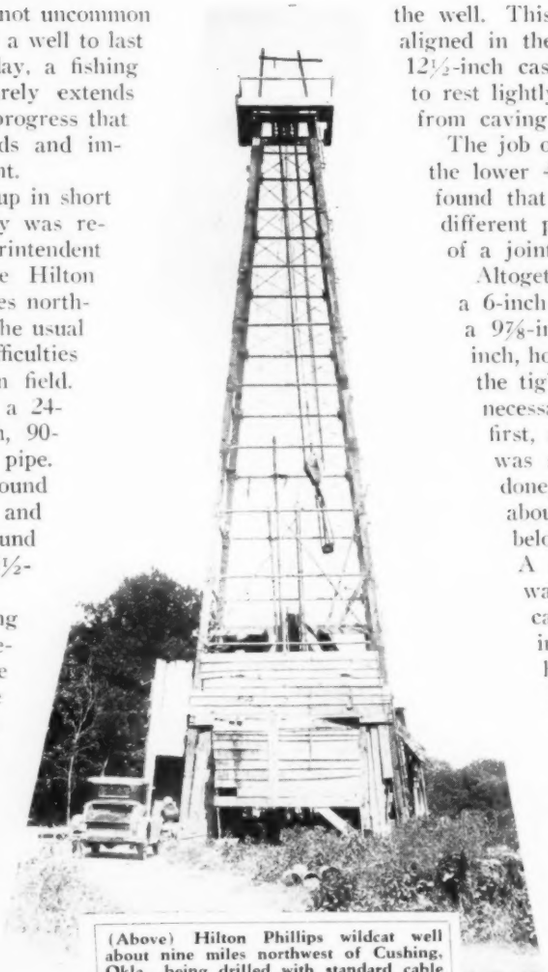
As the collapsed casing was in the lower part of 450 feet left in the hole, and the open hole above 900 feet and below the bottom of the 15½-inch at 635 feet was caving (water was standing in the hole to within about 200 feet from the surface) it was decided to straighten up the short joint of 12½-inch casing and rerun the upper 900 feet that had been pulled from the well. This was done. The short joint was aligned in the hole and the upper 900 feet of 12½-inch casing hung on clamps and allowed to rest lightly on the free joint so that trouble from cavings was eliminated.

The job of swedging the collapsed casing in the lower 450 feet was then started. It was found that the casing had collapsed in two different places and about the whole length of a joint in each place.

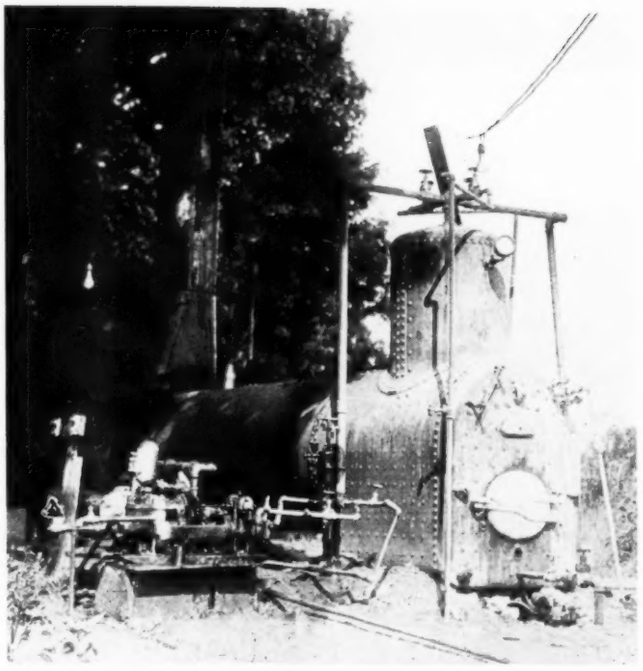
Altogether, five swedges were used. First, a 6-inch swedge was run, then an 8-inch, a 9⅞-inch, and a 12⅛-inch. The 12⅛-inch, however, could not be driven through the tight places in the casing and it was necessary to run an 11¼-inch swedge first, after which the 12⅛-inch swedge was successfully used. When this was done, the drilling tools were run and about 100 feet of hole drilled ahead below the shoe of the 12½-inch casing. A string of 10-inch 45-pound casing was then run inside the 12½-inch casing. From this point on the 10-inch casing was carried and the hole drilled and under-reamed to 1,702 feet, where the 10-inch casing was finally landed.

From the time the 12½-inch casing collapsed until the 10-inch casing was run, the total elapsed time was only about 12 days. A string of 8-inch, 32-pound casing was landed at 2,200 feet in the 10-inch hole.

Equipment used on the well consisted of an 84-ft. standard wooden turnbuckle derrick with 22-ft. base. It was equipped with 6-inch special rig irons. A 12-inch by 12-inch steam engine with totally enclosed crankcase and oil bath was the prime mover used. Power was furnished by a 70-h. p., 175-pound working pressure steam boiler. Fuel oil was burned at the boiler and also in the furnace for dressing bits. All bits were dressed right at the well.



(Above) Hilton Phillips wildcat well about nine miles northwest of Cushing, Okla., being drilled with standard cable tools. (Below) Dick Peebles (left), tooldresser, and D. N. (Red) Santee, driller, of the crews on the well.



Boiler, boiler feed pumps and lighting units.

An average of 15 barrels of oil fuel per day was used at the well. This includes the fuel used in the bit furnace. It includes also the fuel for steam used in pumping water from a nearby well. About 200 barrels of water per day was the average volume consumed at boilers and around the rig.

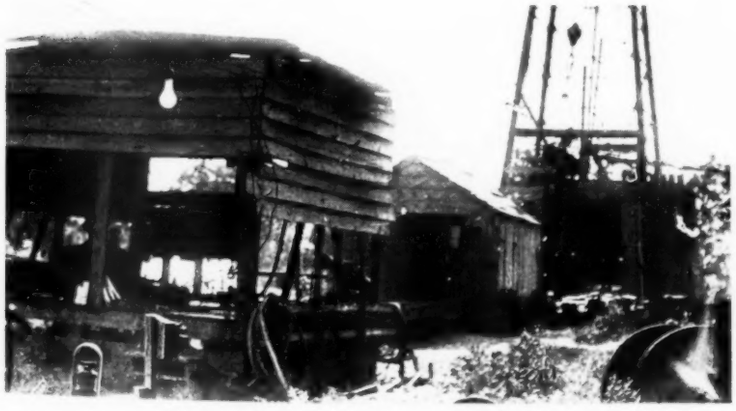
All water used in the boiler was chemically treated, about one quart of chemical per day being required. In addition, the boiler was washed out once a week.

A new 7/8-inch drilling line was installed when the well was started, and despite the fact that most of the drilling had been done in a hole full of water and the line had been used on the fishing job just described, the line was still in use and in good condition.

The ease with which this fishing job was completed is by no means an isolated instance of what is being done today with cable tools, but is typical of what takes place in the average well. This is one reason, where time is not an important factor, why cable tools are popular for use in drilling wildcat wells.

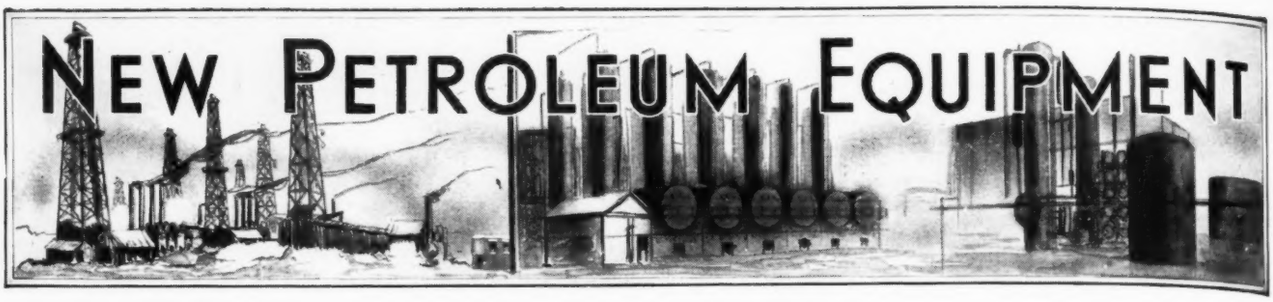
Several other fishing jobs occurred on this well, but they were of a comparatively minor nature and occasioned no special difficulties or appreciable loss of time. Fishing jobs are likely to occur on any well, even when the utmost care is exercised. Abrupt changes in the hardness and character of the formations penetrated is a common source of trouble. The standard cable-tool well is much less affected in this respect than in the old days. With the better grade of materials and improvements in equipment design available for the average standard cable-tool rig today, it is still in wide use—much more so than ordinarily supposed — for drilling, especially where the formations are hard, or in areas where there is any thickness of cavernous limestone rock to be drilled, or in wildcat territory where the drilling is not too deep and where the element of time is not too pressing.

Great advances in drilling tools and equipment in recent years, combined with the greater skill of the drilling crews, have likewise been instrumental in cutting down to a minimum finishing jobs on the average cable-tool hole. When a fishing job does occur, it usually is of short duration and is cleaned up without jeopardizing the well.



(Above) Engine house, forge house and boiler.

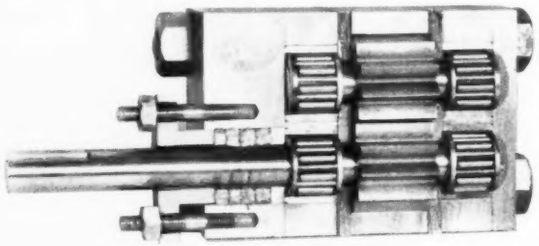
(Left) Forge house at the well, where all bits are dressed.



Northern Precision Rotary Pumps

NORTHERN PUMP COMPANY, Minneapolis, Minn., announces a new series of Precision Rotary Pumps in its Nitralloy line. This new series is known as the "XD" series and is the next larger size to the first group of "XA" pumps, built of Nitralloy steel.

The capacity range of the "XD" series is from one G.P.M. to 15 G.P.M. Two types of bearing construction are available. Nitralloy bearings for supporting the pump shafts are used in pumps to handle fuel oil, gas oil, glucose, coolant, or any other liquid with little or no lubricating value. Roller bearings are incorporated in the "XD" pumps to be used for handling clean lubricating oil, especially for high pressure conditions such as 1,000 pounds.



Northern Precision Rotary Pump.

Because of the high efficiency and wear resisting qualities, the manufacturers state these pumps are ideal for hydraulic hoists, lifts, dump trucks, stokers, crane conveyors, presses, bulldozers, snow plows and machine tools of all kinds requiring hydraulically actuated feeds, chucking and table travel.

Series of High Speed Gear Units

THE Farrel-Birmingham Company, Inc., Buffalo, N. Y., has developed and standardized a series of gear units suitable for speeds up to 6,000 r. p. m. and powers from 120 horsepower to 2,500 horsepower, with ratios up to 10 to 1 for either increasing or reducing speed.

This new series of gear units is especially adapted for connecting Diesel or gas engines to centrifugal pumps. The latter are designed to operate at speeds ranging from 1,200 r. p. m. to 3,600 r. p. m., and the larger engines usually operate at speeds from 225 r. p. m. to 600 r. p. m.

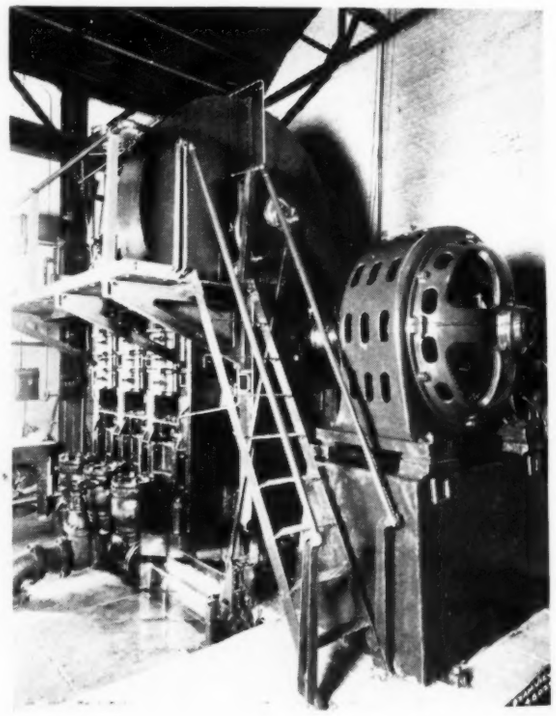
The newly developed unit has a pair of herringbone gears with accurately generated continuous teeth. Precision in gear cutting has been developed to such an extent that accuracy within .0003 inch is obtained by the use of the most modern gear cutting equipment. The proportions of the gears, as regards number of teeth, pitch, face widths, diameters, depth of tooth, helical angle, proportions of addendum of pinion to addendum of wheel, are chosen on a scientific basis and with special consideration as to whether the gears are to be used for increasing speed or decreasing speed.

Synchronous Motor Driven Reciprocating Pump Equipped With Unloader

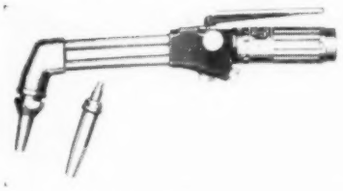
THE Electric Machinery & Mfg. Company, Minneapolis, Minn., recently installed a synchronous motor drive for a triplex reciprocating pump equipped with an automatic unloader which works in conjunction with the motor control to unload the pump automatically. The motor is 250 h.p., 720 r.p.m. The unloader is of the Holveck type.

Without the unloader (because it is not feasible to provide the motor with full-load starting torque), the pump must be unloaded manually by an operator, and manually loaded when the motor is up to speed and synchronized. With the automatic unloader, working in conjunction with the frequency responsive control, the entire starting operation is made automatic, it being necessary only to push the start button.

A magnetic solenoid operating a pawl controls the rotation of a cam shaft for holding open the suction valves. The lifting cams are operated by a rod connected eccentrically to the pump crank shaft. When the solenoid is de-energized the cams are so rotated that the suction valves are held open during the normal pumping stroke. When the solenoid is energized the cams are rotated away from the suction valve lifts and stopped to permit regular pump operation.



Prest-O-Weld Cutting Apparatus



THE Linde Air Products Company, 30 East 42nd St., New York, N. Y., has recently added a cutting blowpipe and a cutting attachment to its new line of Prest-O-Weld medium-pressure apparatus of the detachable valve body design. The new cutting apparatus includes the Prest-O-Weld Type C-105 cutting blowpipe and the Prest-O-Weld Type CW-105 cutting attachment.

These two types of cutting apparatus, together with Types W-105 and W-106 welding blowpipes previously announced, can all be used interchangeably with the same detachable valve body. By means of the detachable valve body, the operator can change easily and quickly from a full size welding blowpipe to a smaller welding blowpipe, to a full size cutting blowpipe, or to a cutting attachment without detaching the hose or hose connections and without use of a wrench.

The locking device for connecting the detachable valve body to any one of these blowpipe handles consists of a locking bolt and wedge-shaped locking screw. The locking screw is operated by turning a ring and draws the detachable valve body and blowpipe handle together, making a gas-tight joint.

The blowpipe is light and well-balanced, but at the same time it is of sturdy construction, according to the manufacturer. It is furnished as standard with four cutting nozzles and a 75-degree angle head. If required, a 90-degree angle head can be furnished.

The Prest-O-Weld Type CW-105 cutting attachment is of the single joint design and attaches directly to the valve body. It will readily cut metal up to two inches in thickness. Because of its small size, only 11 inches over-all, it can be conveniently carried in the pocket of the operator when not in use.

Test Water Cooling Coils

THE sampling of steam and water at various points in the power cycle has come to be a vital necessity in modern power plant operations. In order to secure truly representative samples it is necessary to provide adequate cooling of the hot sample to room temperature while still under pressure. A neat, compact and highly efficient method of securing representative test water samples is now offered by Bailey Meter Company of Cleveland, Ohio, in the Dieform Test Water Cooling Coil.

These coils, which consist of a tube within a tube, are made from copper tubing and Dieform compression fittings. In operation the hot test sample enters the smaller inner tube at the top while the cooling water enters the outer tube at the side outlet on the bottom. Cooling water completely surrounds the inner tube as it passes upward through the annular space between the tubes to the side outlet at the top.

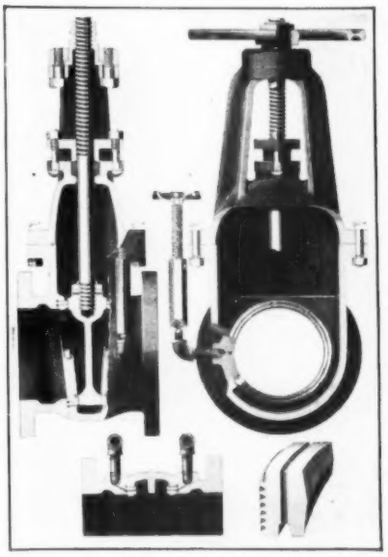
The test water cooling coils are designed for working pressures up to 1,500 pounds per square inch and may be built specially for high pressures if desired.

Norris Oil and Gas Separator

THE Norris, Johnston Type, Oil and Gas Separator has been placed on the market by W. C. Norris, manufacturer, Tulsa, Oklahoma. A feature of this separator, according to the maker, is the lack of all adjustable delicate mechanism in positions readily accessible to persons passing by. The separator was designed in this manner to prevent casual adjustment by incompetent persons with curiosity as to what might happen if some different adjustment was tried. The only part that may be moved by anyone on the ground without tools is the end of the regulator valve shaft, yet it requires force enough to increase the submergence of the regulator force. The fluid regulator is bolted to a flange opposite the manhole but has the float inside the tank where it is protected from the well flow.

This separator has as standard equipment steam coils, by which means steam may be injected through the separator for the purpose of heating the fluid, which will aid in the separation of the oil and gas. It is provided with ample provision for immediate removal of liquids obtained from the gas and the areas of outlets for the gas are increased at each place where the flow is diverted so that there is no back pressure in the separator. All connections of parts that do not have to be removed are welded, thus giving maximum resistance to wear and tear in moving the separator from place to place.

Lubrotite Gate Valves



THE Lubrotite Gate Valve, a valve with a lubricant-seal principle of tight seating, has a unique duct system for introducing a lubricant-seal between the seating surfaces, according to Reading-Pratt & Cady Company, Inc. The valve is sealed tight even though the seating surfaces have become damaged by coke deposits, abrasions or corrosion.

The general dimensions of these lubricated valves are the same as regular non-lubricated valves, so Lubrotite valves can be used for replacement service without changing the piping system in any way. They are made in both Pratt & Cady standard and extra heavy iron body patterns and in Reading Electric Cast Steel.

These valves are ideal for gas lines, gasoline lines and general oil refinery services, such as handling air, gas, water, chemical, petroleum products, etc., according to the makers.

The lubricant-seals are packed in convenient pocket sized boxes—24 cartridges to a box. Only a small amount of lubricant is needed for an application.

Full details concerning Lubrotite valves can be obtained by writing to the Reading-Pratt & Cady Company, Inc., Bridgeport, Conn.

Halliburton Cementing Device

THE Halliburton Oil Well Cementing Company, Duncan, Okla., is prepared to furnish a cementing device which not only allows the continuous cementing of a combination string of casing (which is a string consisting of casing with perforated screen or liner on the bottom, the liner being the same diameter as the casing), but provides a simple means for washing the perforated liner or screen to bottom prior to cementing. This washing feature does away with the necessity for a wash pipe and consists of an inner lining material to cover the perforations to allow circulating around the bottom of liner or screen perforations when running casing. The lining material is cut and washed out of the casing immediately after the cementing plugs are drilled, and is so treated as to prevent clogging of the perforations.

The cementing feature consists of ports through which the cement passes, the ports being closed until the cement reaches them, at which time they are opened by means of the cementing plugs.

Among the advantages for this device, besides allowing the running of both liner and casing in a full sized hole and the elimination of a wash pipe which has many disadvantages, is that it affords a simple means for continuous running and cementing of the combination string and thorough washing of the screen to bottom. This eliminates danger of the perforations being plugged by cavings.

Electric Controller Motor Starter

THE Electric Controller & Manufacturing Co., of Cleveland, Ohio, announces a new motor starter known as the No. 1 Type ZEO Across-the-line Explosion - Proof Starter. It has officially been approved by the Underwriters for Class 1, Group D hazardous locations.

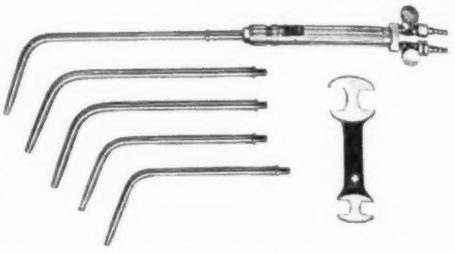
The enclosing case is said to be strong and tight enough to prevent the transmission of any flame that may occur within the case to surrounding atmosphere, and the flanged joint between the upper and lower parts of the case is of sufficient length to cool any gases formed within before they can come in contact with the surrounding atmosphere.

The contactor mechanism and overload relays are mounted on a slate base which is removable from the case. The main contacts and overload relay contacts are oil immersed and all working parts are kept well lubricated and protected from corrosion by capillary attraction of the oil.

The terminals are located above the level of the oil so that the oil will not cause deterioration of the insulation on the wires. This design meets the Underwriters' requirements because the enclosure is heavy enough to withstand an explosion.

The maximum ratings of this starter are 5 horsepower, 110 volts, and 10 horsepower, 220, 440 and 550 volts.

Airco-D-B Style 9800 Welding Torch



THE Air Reduction Sales Co., New York, N. Y., has recently placed on the market a new welding torch known as Style 9800.

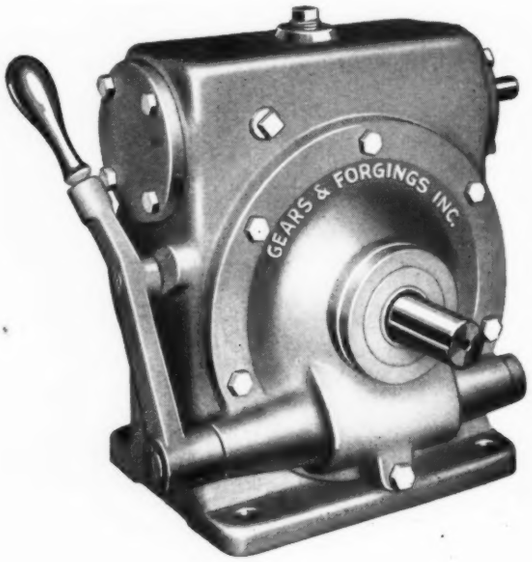
Important new features of this torch are as follows: Ribbed handle, new type mixing head nut, oxygen and acetylene ball seat type needle valves, needle valves easily repacked and an unusually soft flame characteristic.

The ribbed handle is said to afford a positive gripping surface without harshness to the hand. The use of a wrench to properly position the tip each time one is changed has been eliminated through the design of the new mixing head nut. A skirt has been added to the hexagonal nut, allowing it to be loosened or tightened by hand. If for any reason the mixing head nut cannot be loosened by hand, a wrench can be applied to the hexagonal nut.

Two-Speed Worm Gear Reducer

A TWO-SPEED worm gear reduction unit, designed for either horizontal or vertical drives of ⅛ horsepower and up where two speeds are required, has recently been introduced by Gears and Forgings, Inc., Cleveland, Ohio. This type of speed reducer is manufactured integral with motor or as a separate reduction unit, in speed reduction ratios ranging from 4:1 to 150:1.

The unit consists of a worm and worm gear and a set of differential gears, the driving shafts and their Timken roller bearings all enclosed in a sturdy leakproof and dustproof cast housing. The two speeds are obtained by means of the differential gearing. The high speed is obtained by moving the small hand lever to the right. This locks the differential to the low speed shaft on which the worm gear and differential gearing rotate as one unit. Movement of the hand lever to the left locks the side gear of the differential, preventing its rotation. Thus one-half of the revolutions of the worm gear are imparted to the slow speed shaft. Change of output speed can be made while the unit is in operation under full load.



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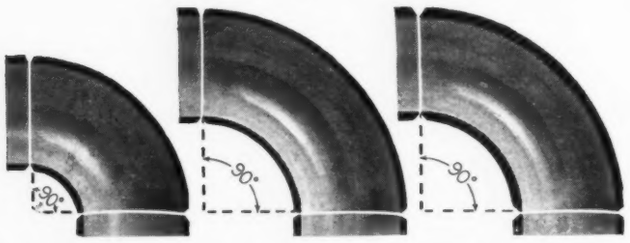
Through your dealer—but avoid a substitute

The Charles N. Hough Mfg. Co.
FRANKLIN, PA.

New Series of Tube-Turns



Unretouched photograph of cut-away sections of 3-inch, 90-degree, Series 1R, 1½R and 1½RX Tube-Turns, showing uniform wall thickness. Inside of fittings painted white, walls painted black for sharper photographing.

SUBSTANTIALLY lower prices apply to all Series 1R Tube-Turns, a new series of the seamless, uniform wall fittings for pipe welding just announced by the manufacturers, Tube-Turns, Incorporated, Louisville, Kentucky.

Like all other Tube-Turns, the new Series 1R fittings are seamless. They are made by the exclusive Tube-Turn process, which produces uniform wall-thickness at all points, insures uniform radius and eliminates all locked-in stress in the metal. Like all other Tube-Turns, the new Series 1R also has the same outside diameter, the same inside diameter and the same wall thickness and wall tolerance as the pipe with which it is used. This, together with the fact that it is made of the same material, is said to greatly facilitate lining up and welding.

The addition of the new Series 1R rounds out and completes the Tube-Turn line, according to the announcement, affording 45-degree and 90-degree elbows and 180-degree return-type fittings for welding in sizes ¾-inch through 20-inch and in virtually all the weights required by modern piping.

Series 1R Tube-Turns are carried in stock by all Tube-Turn distributors. The announcement invites requests for descriptive literature and prices.

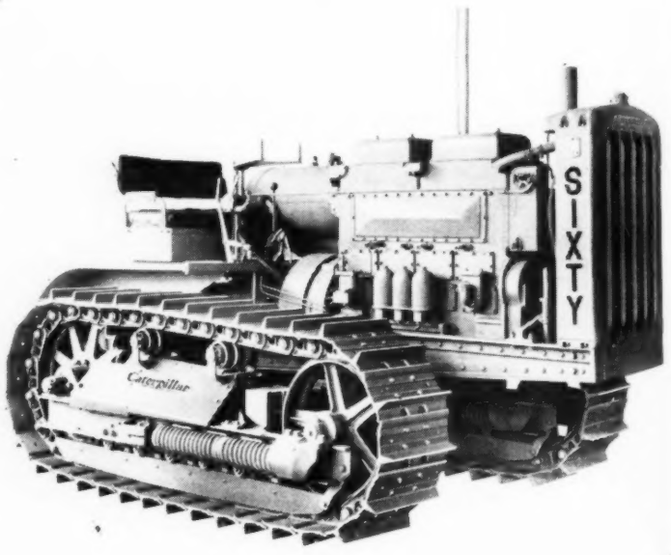
Ripley Microscope

THE Ripley Microscope, product of The Ripley Company, Cleveland, Ohio, offers magnifications of from 40 to 60 times. A feature of the microscope is its handy size and operating features.

The microscope resembles an oversized fountain pen, which makes it easy to place in one's vest pocket and will always make it possible to have a magnifying glass available, whereas the plant microscope might not be available.

The ease of operation permits it to be held in one hand and to be focused by a slight movement of two fingers.

Caterpillar Diesel Sixty Tractor



THE Diesel engine has been developed as a power plant for the Caterpillar Sixty tractor by the Caterpillar Tractor Co., Peoria, Illinois, following years of experimenting and developing under tests in varied conditions and with many different fuels.

Power, traction, transmission, and frame are all co-ordinated in correct balance. In accomplishing this, certain changes in the design of various parts, other than the engine, have also been made. The frame side members of the unit differ from the Standard Sixty. The radiator design has been modified, and a heavy equalizer spring is used instead of an equalizer bar. The tracks are of 34 sections; recoil springs are tandem type.

Bosch fuel injection equipment is used. An important contribution by Caterpillar in the building of this engine is the introduction of sealed fuel injection apparatus. Each tractor is supplied with an extra set of fuel pumps and nozzles, adjusted, sealed and interchangeable as units—avoiding any necessity for field adjustments to the fuel injection system. Should a fuel pump or nozzle ever require adjustment, one of these units may be quickly substituted and the troublesome one returned to the Caterpillar company for servicing.

The Diesel engine develops 63 maximum drawbar horsepower and seventy-five maximum belt horsepower. Its shipping weight is approximately 25,000 pounds.

The engine is started with a small two-cylinder Caterpillar engine, compactly mounted on the left side of the main power plant. The starting engine is cranked by an easily accessible crank. This engine operates on gasoline or other high-volatility fuel—connection to the main power plant is automatically disengaged when operating speed is reached.

. . . Progress in . . . Liquefied Petroleum Gas Industry

By EMBY KAYE, *Skelly Oil Company*

WHEN the books are balanced for 1931 they will show the best year in the liquefied petroleum gas business since the inception of this youthful industry. Possibly the year will not be written down as a big year from the standpoint of new business, but at the same time be it said that less money has been spent that will have to be written off. A number of factors have contributed to this result.

Appropriations for sales promotion have not been what they were in the 1928-1930 years. This business came into being on the crest of the prosperity wave. With high prices, the wider field for exploitation justified a wide and intensive selling effort with the costs that it entailed. Moreover, selling effort of the same calibre and extent was more expensive than at this time.

When bottled gas was brought to the American market, it was as new to the prospective buyer as was the "gas wagon" to the average man at the dawn of the century. He had to be told what gas was, how it was used, what its advantages were, how little it cost, that it was harmless, that there was a large supply in reserve, and a thousand other "hows" and "whys."

All this cost money. Complete portable units were even installed on trucks and taken from house to house to demonstrate the efficiency and simplicity of the new gas—all this to create consumer interest. But this was not all.

In order to facilitate distribution of gas and equipment, and to insure good service in every part of the territory, distributors had to be arranged for and instructed. Contact men were necessary to sell, service men to instruct dealers and consumers. Contact men were required to help and follow up the dealer's prospects. Necessary also was a trained personnel; and it cost a lot of money.

As in any new enterprise, it was found after some experience that some of the equipment had to be redesigned and changed. Particular reference is made to the cylinder valves, manifold valves, and mercury seals. In many instances regulators had to be replaced. Diaphragm valves have almost entirely replaced the earlier stuffing-box-packed valve. The valve replacement alone represented an overwhelming expense. There was no way around it if the gas set was to be made operative without gas loss and without too much attention by the owner of the equipment, and there were stoves to redesign.

Box car and l. c. l. shipments from manufacturing plants, and return of empty cylinders to those plants, cut well into potential profits. And when bottling plants were installed in centers of distribution zones in order to reduce the excessive freight charges and to cut down the idle cylinder days, it was not without expense that bottling and loading crews were installed and trained in the handling of the gas and in the repair of equipment.

Even if the depression years had not brought about curtailed expenditures for these and sundry operations, it is more than likely that sales promotion costs would have been reduced. There is such a thing as over-selling. It is the writer's view that it was time to "rest"—in a measure, to harvest what had been sown in the accumulated efforts.

The dealer territory had been sufficiently canvassed. Moreover, the bad dealers had been weeded out and the better ones were adequately trained. Dealer and prospective consumer were "gas conscious." Dealer salesmen and instructors could be reduced in number. Improved knowledge and better performance of equipment required less from the service department. Bottling plants functioned with the precision of clock-work. On the whole, in every department of the business, less supervisory effort was necessary. Today's work is the more or less orderly filling of orders and the caring for service detail not dissimilar to that rendered by any going utility.

It should not be concluded that all sales promotion expense has ceased. It is only that the expense has been made more commensurate with the requirements of an established product. There has, during the year, been a steady flow of new consumer customers, as well as an increase in the on the books has been materially reduced, and the operating per-customer consumption. The cost of getting a consumer expense per customer has, for the reasons shown, been diminished even without giving effect to the increased volume. This net result had to be achieved if the business was to survive and yet it was accomplished in the face of a decided reduction in the cost of the gas to the ultimate consumer.

There is no question about the permanency of this business. It is here to stay. The several hundred thousand users of this gas have demonstrated its usefulness and their satisfaction speaks for the unique standard of service that is maintained. Up to date the gas consumption has gone chiefly into gas ranges and hot plates for cooking service, but with the development of improved hot water heaters of low B.t.u. input, this field, practically untouched, will be canvassed. This should be an important gas load builder, yet reached at nominal selling expense.

If the marketing s.tuation, from which the most vicious sort of destructive competition has been purged, remains stabilized, those now in the field should have an opportunity of recovering the expenditures which went into the embryo industry. With the small margins in sight, it will require many years, but the results are promising and the effort well worth while.

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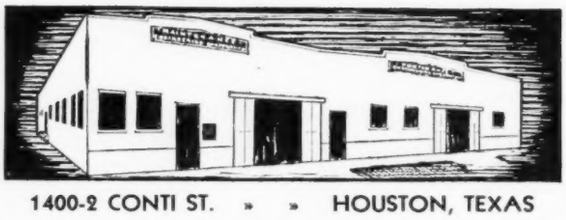

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Head of Crane Company Dies

Richard T. Crane, Jr.

WITH the death of Richard T. Crane, Jr., president of Crane Co., the petroleum industry, as well as other industries, lost one of the most aggressive leaders among manufacturers of industrial equipment. Under his leadership his company was alert to the rapidly changing requirements of the industry as it pertained to valves, fittings, piping materials, and other products manufactured by Crane Co.

Mr. Crane died in New York, November 7, from heart trouble following an illness of 10 days. His heart trouble was largely induced by worry over illness in his immediate family and concern for the welfare of company employes, who, due to the depression in business, had to be laid off or reduced in working time.

Mr. Crane was born in Chicago on November 7, 1873. He entered the employ of Crane Co. shortly after graduation from Yale University in 1895. In 1904 he was married to Florence Higinbotham and to them two children, Cornelius and Florence, were born.

He was elevated to the presidency of Crane Co. in 1914 and during the 17 years he headed the organization the company enjoyed its greatest period of expansion. Included in the list of accomplishments during this period was the building of the great Chicago Works and Montreal Works and the building of the new works in Paris, France, and Ipswich, England. Mr. Crane established the Crane Export Corp.; Crane, Limited, Candad; Crane-Bennett, Ltd., England; Cie Crane, France and Belgian; Potteries at Trenton and Quebec; Enameled Iron Works at Chattanooga, and shops at Birmingham.

In 1921 he built Benjamin Stickney Cable Memorial Hospital at Ipswich, Mass. In memory of his father and mother he donated the tower and carillon to St. Chrysostom's Church and donated "Buffalo Rock," near Ottawa, Ill., in 1929, to the state of Illinois to be used as a state park. He was honored by Hobard College by receiving a degree of Doctor of Laws.

Funeral services were held November 11 at St. Chrysostrom's Church in Chicago with Rev. Herman D. Hutton officiating. Burial was in Graceland Cemetery, Chicago.

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Daily use of the Syfo Clinograph ("the Ink Bottle") enables the driller to *control direction* — quickly — accurately—without the use of acids and with a permanent record of results.

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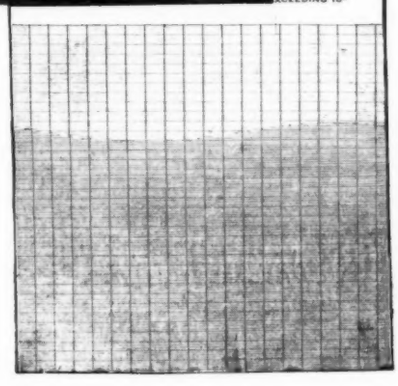

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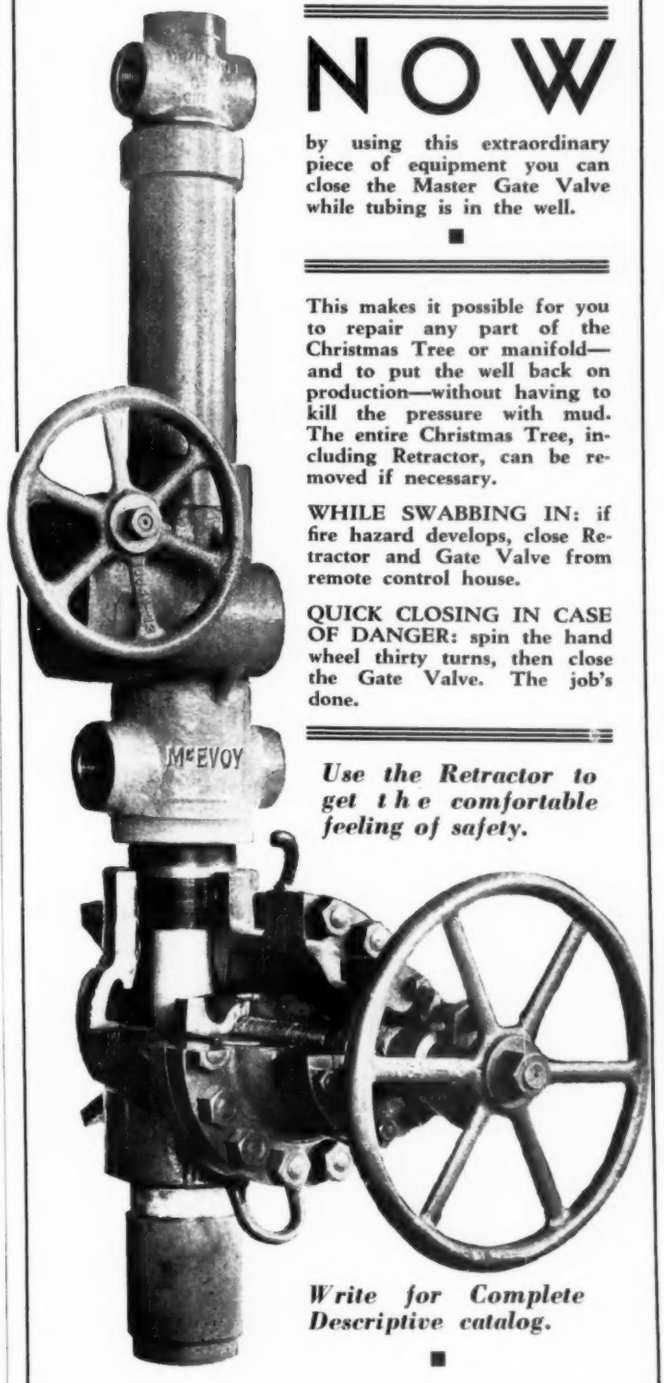

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by using this extraordinary piece of equipment you can close the Master Gate Valve while tubing is in the well.

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RAPID—EASY SCALE REMOVAL

Dearborn Special Formula No. 134 has been used by engineers for many years for thorough and inexpensive scale removal from water lines, boilers, pumps, engine heads and jackets, heaters, meters, cooling coils and evaporators. Easy to use and thoroughly reliable.

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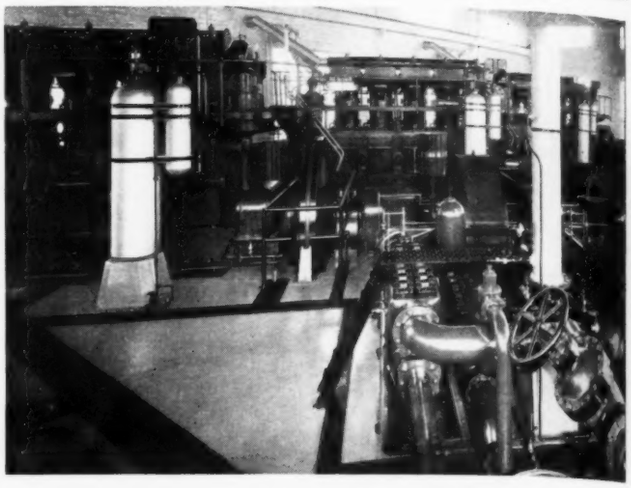
Proper Installation



THE life of gasket material in a Diesel engine pipe line station depends, to a great extent, upon the proper application of the sealing material. Assuming the material is properly ordered there are two phases in the installation of gaskets that will bring about its early failure if overlooked. Both are equally important and too much stress cannot be given to see that they are properly observed.

Improper cleaning and finishing of the metal faces against which the gaskets must fit is a common source of trouble and the failure to properly tighten down the bolts takes its toll in failures and delays resulting from shut downs.

Fabricated gaskets made of a good grade of compressible asbestos and jacketed with a ductile metal covering are widely and satisfactorily used. It is common to find the period of service of such gasket material has extended over several years in pipe line stations.

At these stations the gaskets on the cylinder heads fit easily inside the bolt holes and the groove on the liner. When they were installed the faces were thoroughly cleaned and smoothed and the top side coated with graphite.

Applying a liberal coat of graphite is done for a dual purpose. It to some extent preserves the asbestos from hardening and also prevents the gasket from sticking to the head whenever necessary to remove the cylinder head. As long as it does not stick to the head when the latter is removed the gasket will have a long life.

On some installations the graphite is put on dry and smoothed out uniformly over the gasket with a soft paint brush. On others the graphite is mixed with a light grade of engine oil and brushed on. In either application particular attention is given to see that no lumps form on any part of the gasket, which should be uniformly coated.

When the cylinder head is moved back in place the first two bolts taken up were on opposite sides of the bolt circle.

# of Gaskets Extends Period of Service

Diesel Powered Pump Station.

The next two were 45 degrees around from the two tightened bolts and also opposite each other. By tightening two bolts at the same time and directly across the bolt circle the head was tightened down more uniformly.

It has been the experience of most machinists that a new gasket should be installed whenever a gasket is removed or when it sticks to the metal when removing a cylinder head. Almost invariably they are distorted and part of the gasket is torn away when the gasket is removed. With an imperfect gasket a tight joint cannot always be made regardless of the care taken in smoothing the surfaces.

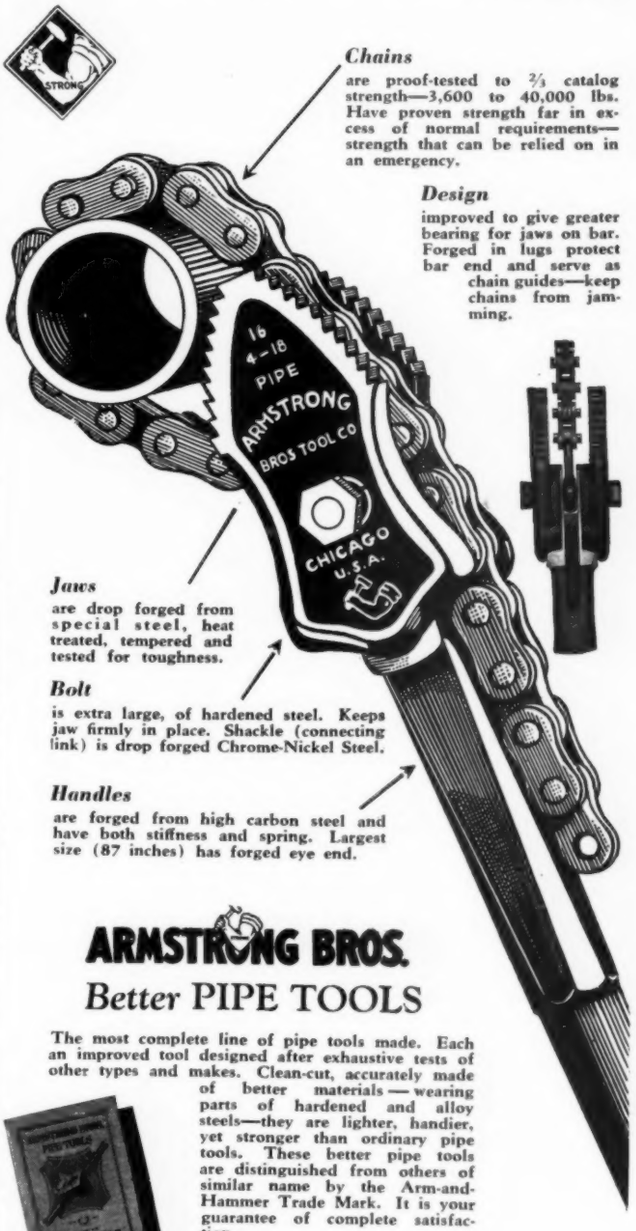
In smoothing down the faces before installation of the material a piece of brass, to be found around most any pipe line station, is commonly used to scrape the metal surfaces. Some, however, use steel. Brass has the advantage of wearing to a sharp edge, and while its cutting action is slower than steel it will not cut into the steel face of the metal being smoothed.

Another of the advantages of metallic asbestos gaskets is that leaks may sometimes be stopped by tightening down on the gasket. If the leak is a small one around the gasket or due to a small scratch on the steel surface the opening may be closed by a slight tightening of the bolts.

Manufacturers recommend that a gasket covering the entire flange from inside of the bolt circle to the inside edge of the pipe not be used. Tests have shown an easier and more satisfactory joint is made by using a narrow gasket. This is because the narrow gasket places less strain on the bolts. As an example a gasket for a 5-inch pipe serves best with about a 7/8-inch wall and a gasket with a 1-inch wall is best used for a 10-inch pipe.

But regardless of the selection of gasket material their period of service will, to a great extent, depend upon the care exercised in application.

ARMSTRONG BROS.
CHAIN TONGS



Chains
are proof-tested to 3/4 catalog strength—3,600 to 40,000 lbs. Have proven strength far in excess of normal requirements—strength that can be relied on in an emergency.

Design
improved to give greater bearing for jaws on bar. Forged in lugs protect bar end and serve as chain guides—keep chains from jamming.

Jaws
are drop forged from special steel, heat treated, tempered and tested for toughness.

Bolt
is extra large, of hardened steel. Keeps jaw firmly in place. Shackle (connecting link) is drop forged Chrome-Nickel Steel.

Handles
are forged from high carbon steel and have both stiffness and spring. Largest size (87 inches) has forged eye end.

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The most complete line of pipe tools made. Each an improved tool designed after exhaustive tests of other types and makes. Clean-cut, accurately made of better materials — wearing parts of hardened and alloy steels—they are lighter, handier, yet stronger than ordinary pipe tools. These better pipe tools are distinguished from others of similar name by the Arm-and-Hammer Trade Mark. It is your guarantee of complete satisfaction.

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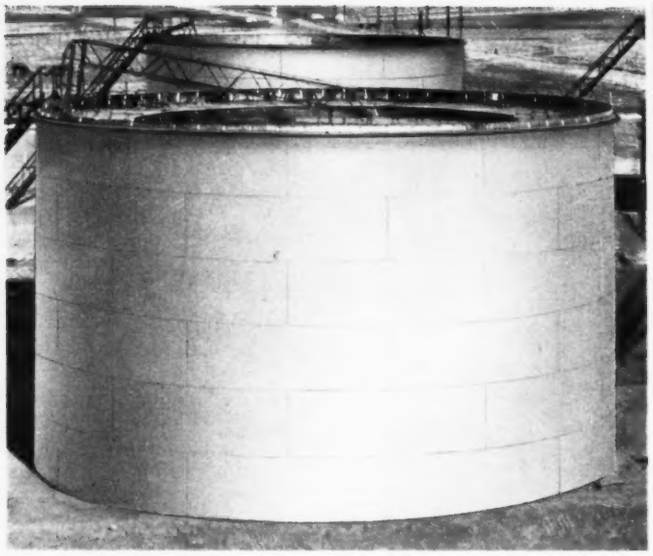

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DURING the past 8 years we have introduced a number of unique and important improvements in oil storage tanks. The designs shown here are today making possible economies in oil storage comparable with those effected by careful engineering in other branches of the industry. Our engineers will be glad to furnish evaporation data, and quote on any type of storage container — also elevated tanks, smokestacks bubble towers, absorbers and special refinery platework. Please address our nearest office.

The illustrations from the top down show: (1) Horton tanks with Wiggins Pontoon Roofs; (2) a Hortonsphere (25 lbs. pressure) for storing extremely volatile products; (3) a Hortonspheroid (15 lbs. pressure) for storing products that are likely to vaporize at atmospheric pressure.

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PE-12-Gray

THE BROWN ELECTRIC FLOW METER is featured in a new broadside published by The Brown Instrument Company, Philadelphia, Pa. The fact is brought out that unless departmentalizing steam accounting is done, comparative efficiency in the use of steam in one department may go unnoticed.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has published several new bulletins on electric motors as follows: Bulletin No. GEA246C on general-purpose synchronous motors; No. GEA-560B on constant-speed, single-phase motors type SCR; No. GEA1475 describing single-phase vertical motors, type SCR; and Bulletin No. GEA1483 on medium-speed alternating current generators.

McLEOD & HENRY COMPANY, Troy, New York, has recently published a 32-page bulletin describing their boiler furnace linings, walls and arches made of steel mixture refractories, and other steel mixture products. It is profusely illustrated with photographs, diagrams of typical settings showing various types of applications.

BINKS MANUFACTURING COMPANY, Chicago, Ill., has printed a bulletin describing its complete line of water cooling equipment such as spray ponds, spray towers, deck-type towers, etc., as manufactured by this company.

BABCOCK & WILCOX COMPANY, New York, N. Y., has issued a new publication which outlines the evolution of marine steam propulsion from low pressure plants to the present economical use of modern steam. The bulletin also deals with the economies of steam propulsion from the standpoint of fuel consumption, cost of fuel, lubricating oil costs, flexibility of operation and other important factors.

PYRO-MORTAR, a dry refractory cement, a product of Quigley Company, New York City, is described in a new bulletin being distributed to the trade. Pyro-Mortar is especially adaptable for bonding fire brick, for plaster coatings, for pointing up cracks and reclaiming eroded furnace walls, and other similar applications.

THE WESTCOTT VALVE COMPANY of East St. Louis, Illinois, has announced the completion of a new 130-page catalog which contains information and data covering valves of the gate type, both in steel and iron, together with certain fittings and combinations exclusively designed and manufactured for the oil and gas industry.

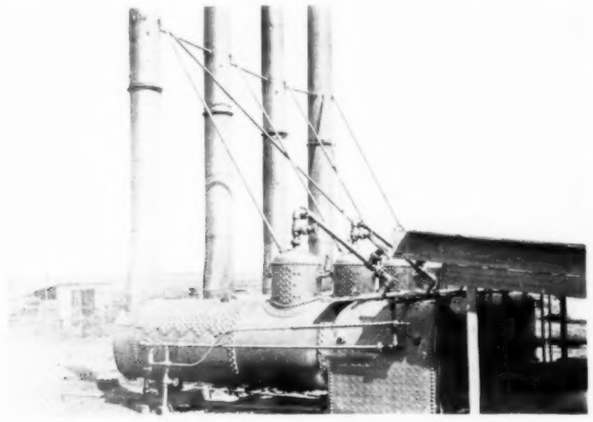
THE INTERNATIONAL DERRICK & EQUIPMENT DIVISION of International-Stacey Corporation, Columbus, Ohio, has just issued a 24-page bulletin on Ideco substations, transmission towers, steel poles and special structures.

REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has issued a newly revised 64-page booklet entitled "The Path to Permanence." It is classified under A.I.A. File No. 12 and 31 and gives up-to-the-minute information on Toncan Copper Molybdenum Iron Sheets. It also illustrates various types of installations of this rust and corrosion resisting sheet metal.

New Type Oil Field Boiler Braces

A NEW means of bracing boiler smokestacks has been adopted by several drilling contractors in the Oklahoma City field. It consists of steel braces instead of the usual guide wires. This practice was first used in the north end of the field, which is in the city limits and where congested conditions offer insufficient room for running lines.

Cross braces are bolted between the three or four boilers used, with additional bracing supplied by running another



Picture showing boiler braces on a Fain Drlg. Co. test.

small steel arm from the smokestack to the top of the boiler dome. Two cross braces from the outside boiler smokestacks to the center boilers give this method additional strength.

This method has proven itself a sturdy means of bracing oil field boiler smokestacks and has sufficient strength to withstand the strong late summer winds. In addition it leaves the ground surrounding the boilers free from obstructions.

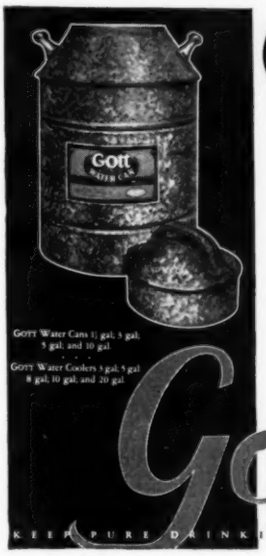
Petroleum Electric Company Becomes Allen-Bradley Oklahoma Agents

THE Petroleum Electric Company has been appointed agents in the Oklahoma territory for the Allen-Bradley Company, 1311 S. First St., Milwaukee, Wisconsin, manufacturers of controllers for A. C. and D. C. motors used in the petroleum and other industries. Allen-Bradley equipment will be handled by the Petroleum Electric Company from their main offices at 522 Commercial Building, Tulsa, and their branch office at 531 W. Main St., Oklahoma City.

P. M. T. A. Officers Nominated

AT the regular monthly meeting of the Petroleum Motor Transportation Association the nominating committee reported the following officers for the coming year: President, C. J. Martin, Phillips Petroleum Company; First Vice-President, T. G. Price, Shell Petroleum Corporation; Second Vice-President, C. E. Jackson, Mid-Continent Petroleum Corporation; Secretary-Treasurer, F. P. Xopper, Gypsy Oil Company. Directors: W. K. Atchison, Pure Oil Company; R. J. Bevington, Barnsdall Oil Company; and Charles Meyers, Gypsy Oil Company.

The November meeting was directed by the Petroleum Safety Council and was featured by a talk on Russia given by Dr. R. C. Beckstrom, who recently returned from that country, where he was employed by the Russian Government. Dr. Beckstrom did not speak upon the safety to human bodies but the necessity of protecting the American Government and ideals from the Communistic form as carried on under the Soviet rule.



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Best for gauging, strapping, engineering and general measuring requirements of the oil industry.

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420 Lexington Ave., New York City

Flexibility *of* Control Features Efficient Operation *in* Gas Booster Station

By F. B. TAYLOR, Jr.

THE Panhandle Eastern Pipe Line Co. recently completed the construction and testing of the yard lines and equipment of their centrally located compressor station one and one-half miles south of Louisburg, Kansas, on their 1,100-mile gas line from the Texas Panhandle to Indianapolis. This station forms the connecting link between the 5,000-horsepower station at Liberal, Kansas, which receives natural gas from the Panhandle district in Texas and the Hugoton field in Kansas, and the 4,000-horsepower compressor station nearing completion at Glenarm, 11 miles from Springfield, in Illinois.

Particular care in the selection of the site, as well as the equipment being used, arrangement of the buildings, yard piping, etc., makes this station outstanding where efficiency, flexibility of operation, and beauty of appointments are concerned.

Gas entering the station from the west arrives through the 24-inch main line and passes through four 500-pound-test scrubbers, in which a mineral seal oil is used as a cleansing fluid. An unusual hookup of the charging system allows the operator to drain or charge any one or all of the scrubbers either while idle or during full operation.

From the scrubbers the gas is passed directly to the compressor intake manifold, 24 inches in diameter, into which all the individual compressor intakes are welded. This construction is duplicated in the discharge header which parallels the intake manifold in a concrete alley. Engine exhaust mufflers and intakes to the power cylinders are located on the opposite of the main building.

The high temperature of the discharged gas, resulting from the increased molecular friction during the act of compression, is brought to normal in the after-cooler. Here the gas passes through a bank of three-quarter inch brass tubes, over which water is constantly flowing; in this manner dissipating the excess heat. From the after-cooler the gas passes into the station 22-inch discharge line through which it is transported to the awaiting markets in the east.

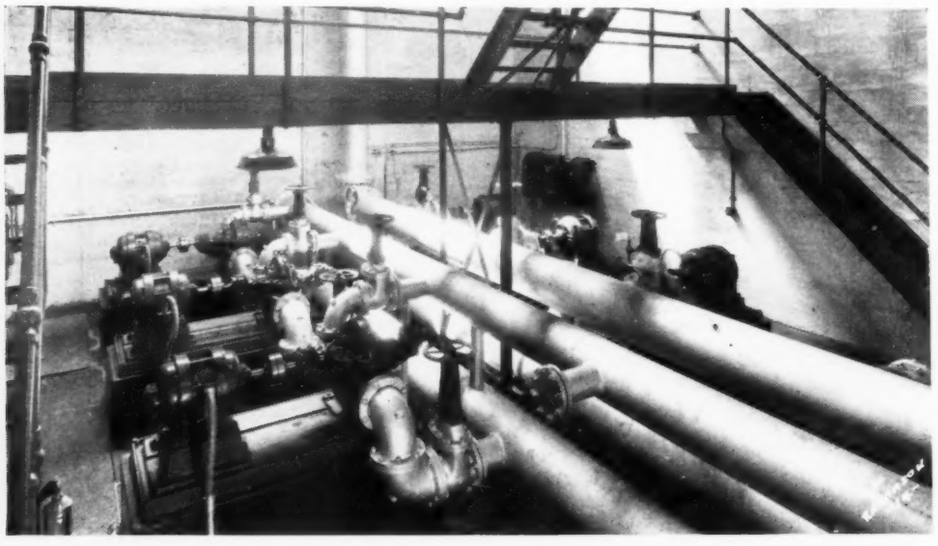
In order to give the station an added utility an 8-inch by-pass has been placed from the 22-inch discharge line to the 24-inch intake in such a manner that the gas may be boosted either to the east or to the west. A main line by-pass allows the gas to flow by the station without entering the station proper.

The main building, housing five 1,000 horsepower twin tandem power units, driving two 13 by 36-inch compressors at 125 r.p.m., is of heavy sheet metal over a steel framework. This construction is true of all of the buildings, with the exception of the office and the employees' cottages. There is absence of lines and valves on the main floor of the compressor building, as all piping is hung by supports from the ceiling of the basement, with the intake, by-pass and other valves immediately outside, over the concrete manifold alley. They are operated from a three-foot steel walkway extending the length of the building.

The floor of the room is of concrete, the surface being impregnated with a special black coloring matter, which makes the floor impervious to oil and water. Lighting is by vapor proof fixtures, which are set at angles to the vertical, as well as directly overhead, thus affording diffused illumination without the usual glare. Large swinging window lights, aided by vanes set in the roof, allows ventilation. Circulation of air may be forced by means of three large, overhead fans. In cold weather the air from these is blown through steam coils, affording complete control over the temperature of the room.

Two boards for tools are mounted upon the walls. In each of the four corners are fire hydrants, with hose attached. Hand extinguishers of different types are hung conveniently from brackets in the basement as well as on the main floor. A gauge board mounting the intake and discharge pressure gauges, fuel pressure gauge, air and water gauges, and a clock is built close to one wall, with the lines to the instruments inconspicuously placed behind the panel. Upon the curved fuel intake manifolds to the power cylinders are an ammeter and a voltmeter, with a "U" type fuel gauge on the opposite side. A 15-ton overhead crane, traveling on a double "I" beam carriage, is capable of reaching every piece of equipment. Two five-barrel lubricating oil tanks are included in the equipment of the compressor room.

Immediately to the east of the main engine room, is the machine shop. A large warehouse, complete with shelves, bins and tool racks is located in one end of the building,



Water circulating pump pit at Louisburg station.

with the locker room, shower bath, and wash room, between. Beneath the warehouse end of this structure is abundant storage for pipe, wire lines, and miscellaneous fittings.

Equipment in the machine shop is ample to supply almost any need which may arise. For any heavy parts which might be built in the shop, a large overhead crane traveling on a track extending through the machine shop and into the main engine room, can be used. Between these two buildings is a driveway where such parts can be loaded or unloaded from trucks.

Turning can be done on either of two lathes, the largest having a 24-inch throw and a 14-foot bed. The smaller of the two has a 5-foot bed and will handle 13-inch stock. Two power drills, one a 24-inch press, the other a bench press for light work, have been installed. A general utility planer, power hack-saw, grinder, forge and anvil, and a welding and cutting outfit, completes the machine shop equipment. The power for all these units, including the blower for the forge, is furnished by directly connected motors.

A work bench and shelves for tools and stock have been built along two walls. Ventilation is obtained in the same manner as in the main engine room, either by a power fan or by swinging window lights. The floor in the machine shop is of concrete, impregnated in the same manner as the floor of the engine room. This is true also of the floor of the auxiliary.

All current is generated by means of 156 KVA, 125KW, 480-volt, 3-phase, 60-cycle, alternators, directly connected to 190-horsepower, vertical, gas-driven engines. Two of these units as well as a light alternator driven by a six cylinder gas or gasoline powered engine are ample for any contingency which might arise.

The current control panel is situated in such a manner that the operator can watch his meters while making adjustments on any of the three units. All voltmeters, ammeters, and other instruments are enclosed behind frosted glass which does not reflect light, which otherwise would make the indicators and scales indistinct.

Two, two-stage belt-driven air compressors supply air to three pressure storage tanks located at one side of the machine shop. The method in which these tanks and compressors are hooked up allows the pumping of air into any one or all of them by either or both of the compressors, giving the utmost in control.

The pump pit, located in the center of the building, contains six motor-driven pumps, three of 850-gal. and three of 1,000-gal. capacity. Two 24-inch water intake manifolds enter the pit from the reservoir or lake. One of the two discharge lines from the pumps carries water directly over the after-cooler, the other empties into the 50,000-gal. overhead tank. A connection on the latter line supplies the water to the cooling jackets of the units at a head of pressure equal to the height of water in the tank. The use of this system allows a few hours' gravity flow from the overhead reservoir in case it is impossible to use the pumps.

Water may be discharged from any one or all of the pumps through either of the two water systems as the discharge headers are connected through a valve controlled by-pass. The operation of a 12-inch valve on the line to the after-cooler assures the utmost in flexibility of water control.

The other end of the auxiliary houses a 68-tube boiler, each tube being 3½ inches in diameter. A steam powered pump is used for charging. Lead surfaced battery table, battery test board, individually connected batteries, a motor-generator set for charging, lubricating oil tanks, and the necessary instrument panel for general operation completes the auxiliary equipment.

A 1,000-watt, swing type projector floods the overhead water tower, which is located in the center of the station lot. Two 12,500-gallon lubricating oil storage tanks, with gravity drains to the service tanks in the operating buildings provides ample storage for oil. When the oil becomes thick, due to cold weather, air pressure may be used to force the flow. Other equipment immediately connected with the operation of the station consists of a water intake look box, water discharge look box, an oil settling tank, and a structure for the measuring and regulating of fuel gas. A six-stall garage is located on the driveway which makes a complete circle through the station. Main walks between the buildings are of concrete, secondary walks being of light grey chat, bordered with faced brick. A four-room, frame office building faces the highway at the entrance to the station.

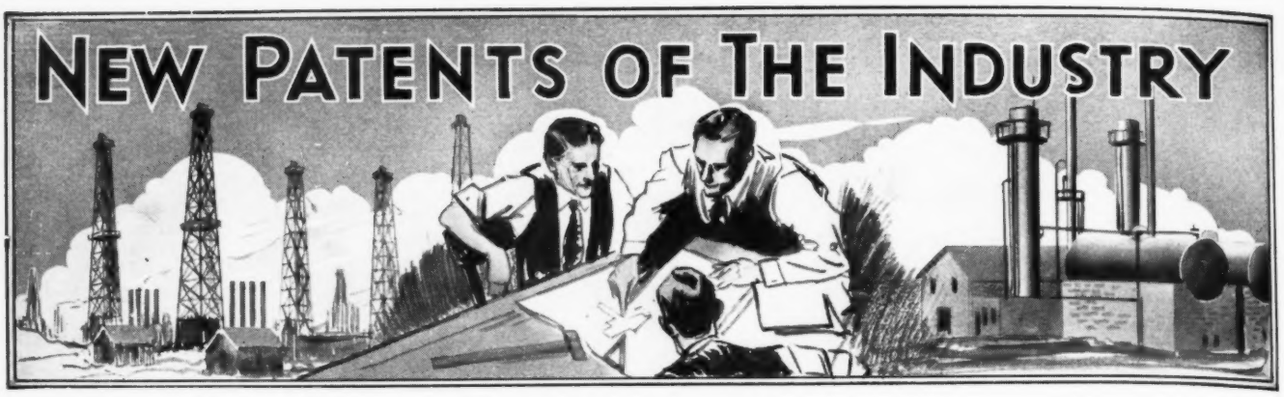
Water, except for drinking purposes, is obtained from a dam built on the property. The water of this reservoir covers 27½ acres, and when at high stage contains 37,288,000 gallons. A considerable water-shed assures a plentiful supply.

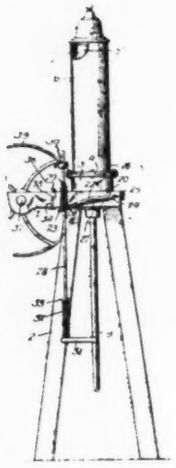
Five well appointed cottages are separated from the station by the width of the dam. These are for the employees, and are located on a semi-circular drive at the crest of a hill, from which the timber has been partially cleared. Each house faces in a different direction and is independent of the others. A four-car garage at the end of the drive, which joins the highway directly rather than through the station, completes the layout of the compressor station site.

The flexibility available in the control of the units, as well as the gas, water and air, tends toward high efficiency and supplies a comfortable margin of safety against undesirable shut-downs when full time operation is required.

After-coolers at Louisburg station with wrench-operated plug valves.

NEW PATENTS OF THE INDUSTRY

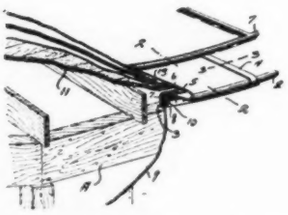




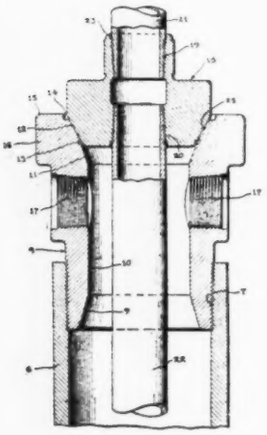
1,815,399. HYDRAULIC OIL WELL LIFT. ELMER CURNUTT, Garnett, Kans. Filed May 16, 1930. Serial No. 452,973. 2 Claims. (Cl. 60—52.)

2. A motor of the class described, a vertical cylinder, a gravity-depressed piston slidable in the cylinder, a rod connected to the piston, a chamber for actuating fluid, a conduit communicating with the cylinder and with the chamber, a pump in the conduit and constituting means for transferring fluid from the chamber to the cylinder, to raise the piston.

1,815,531. OIL TANK CONSTRUCTION. ROBERT R. TUCKER, Tulsa, Okla., assignor to National Tank Seal Company, Tulsa, Okla., a corporation. Filed Mar. 5, 1928. Serial No. 259,368. 5 Claims. (Cl. 220—81.)



1. A storage tank having a roof and a side wall, the roof having its edge spaced inwardly from the side wall and flexible metal connecting elements connected to and extending across the space between the side wall and the roof and permitting relative movement of the side wall and roof, said metal connecting elements being composed of a plurality of circumferentially extending sections slidably engaged with each other.

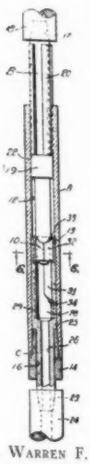


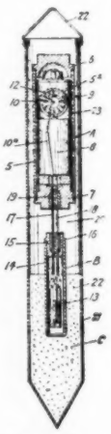
1,827,287. CASING HEAD. EDWARD F. GUIDINGER, Bartlesville, Okla., assignor to Phillips Petroleum Company, Bartlesville, Okla., a Corporation of Delaware. Filed Jan. 6, 1930. Serial No. 418,853. 2 Claims. (Cl. 166—14.)

1. A casing head comprising a metal tubular member having in the upper portion of its bore an upwardly flaring ground contact surface, the bore being provided with an annular recess spacing the upper end of said surface from the top of the head, an upwardly flared guide surface arranged below said contact surface, the bore having an annular groove arranged between the contact surface and the guide surface.

1,833,144. JAR. HARRY P. WICKERSHAM, Huntington Park, Calif. Filed Mar. 20, 1931. Serial No. 524,018. 10 Claims. (Cl. 255—27.)

1. A well tool of the character described including, two sections, means for releasably holding the sections against relative longitudinal movement, the said means being releasable upon a tensile strain being put on the sections and causing turning of one section relative to the other, and means for arresting longitudinal movement between the sections to effect a jarring action between them.

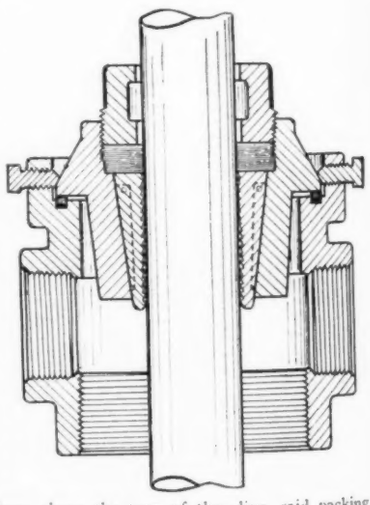




1,832,924. WELL SHOOTING DEVICE. WARREN F. BLEECKER, Boulder, Colo., assignor, by mesne assignments, to William J. Cheley, Tulsa, Okla. Filed Oct. 29, 1928. Serial No. 315,799. 5 Claims. (Cl. 102—4.)

3. In a well shooting device, in combination a water-tight casing, time-controlling means in the casing adapted to be pre-set, a second water-tight casing outside of the first-mentioned casing and its contained time-controlling means, detonating means in the second casing connected to be exploded by the time-controlling means at a pre-determined time, an initial explosive charge outside of both casings but associated with the second casing and adapted to be ignited by explosion of the detonator, and a main sand shattering charge disposed to be ignited by explosion of the initial charge.

1,830,893. TUBING HANGER. SHERIDAN P. TSCHAPPAT, Tulsa, Oklahoma, assignor of one-half to Harold Callahan, Independence, Kansas. Continuation of application Serial No. 88,272, filed February 15, 1926. This application filed June 18, 1928. Serial No. 286,403. 8 Claims. (Cl. 166—14.)



1. A combined tubing hanger and packing off device comprising a bowl having a bore with a tapered part, the upper end of the bore being open, slips arranged within the tapered part of the bore for engagement with a tubing, the upper ends of the slips terminating at an elevation beneath the top of the bore of the bowl, a compressible packing ring disposed within the upper portion of the bore above the tops of the slips, said packing ring serving to force the slips downwardly into engagement with the tubing and also forming a gas-tight joint with the bowl and tubing, a compression ring arranged above the packing ring to force it downwardly with relation to the bowl, the arrangement being such that access may be had to the packing ring by adjustment of the compression ring without raising or disconnecting the tubing or stopping the operation of the well.